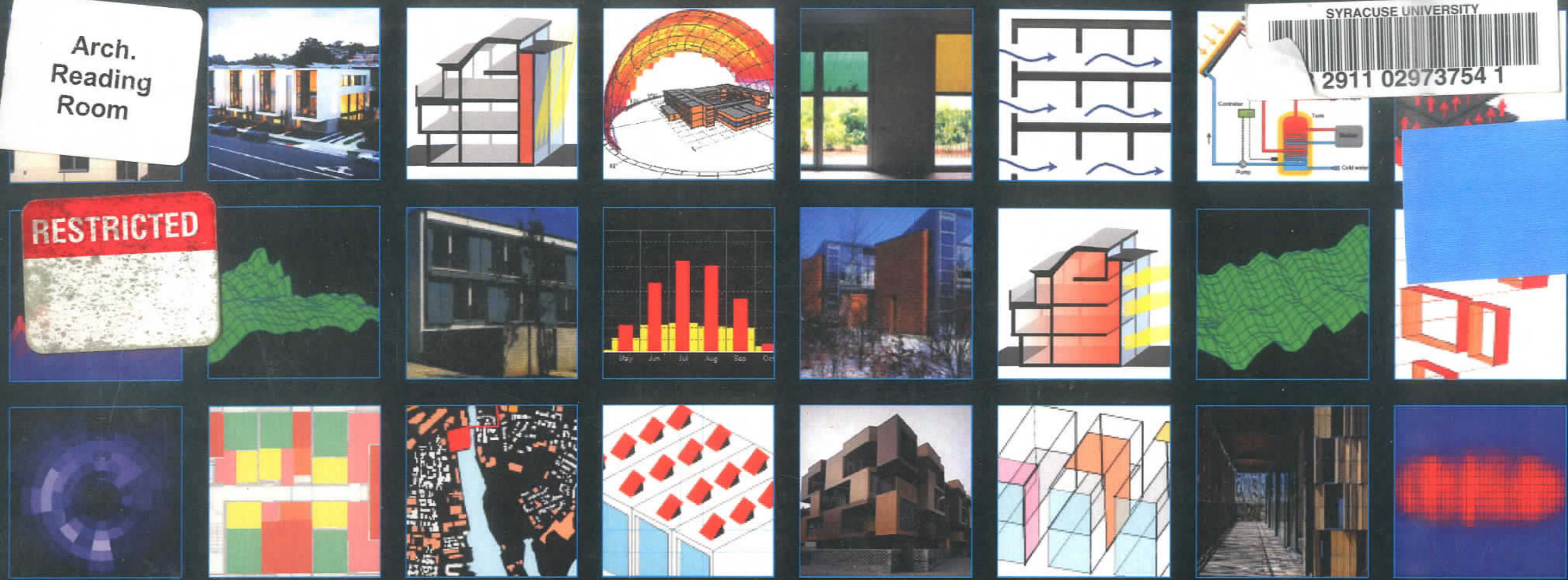
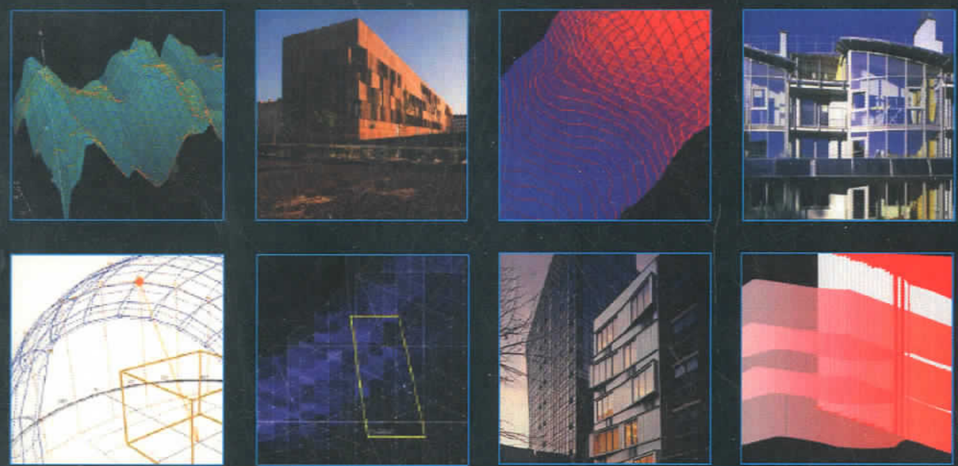
Spring 2009

Leaving a Smaller Footprint: Optimizing Passive Systems For Single Family Attached Housing

David J. Silver





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Advisors:
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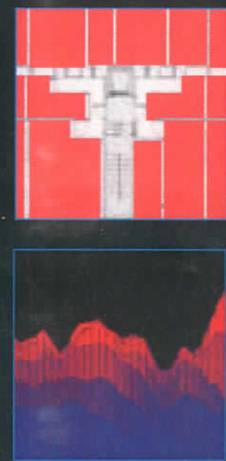

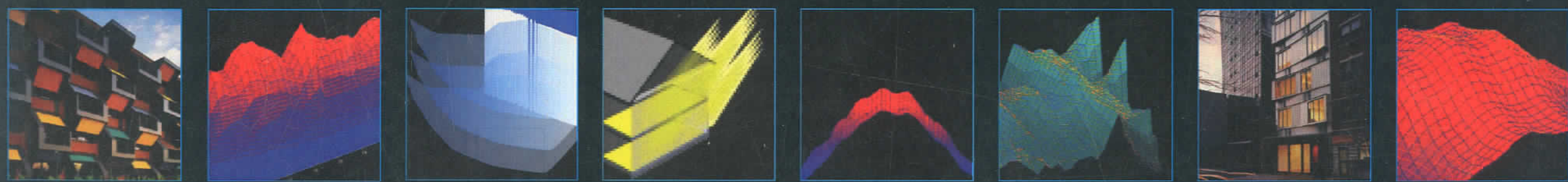

LEAVING A SMALLER FOOTPRINT

Optimizing Passive Systems For Single Family Attached Housing

BY DAVID J. SILVER

Thesis submitted towards completion of a
Bachelor of Architecture degree

Advisors:
Professor Tim Stenson, Professor Daniel De Riva
MAY 2009

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PART 1 **THESIS**

THESIS ABSTRACT

The growing eco crisis has made life difficult for the everyday commuter who travels to the city. Over a quarter million people travel into New York City every day by car creating a higher energy per person deficiency. Many commuters live in rural areas where public transportation isn't present or is inconvenient. This makes the creation of sustainable housing within and around transit oriented developments ever more crucial. "The most eco-friendly house is the one you don't build."Unfortunately, for the climate, most people are dependent on houses. However, finding ways to minimize the impact of the house on the living environment produces the best option for the building and directly addresses the future. Creating the best internal comfort conditions for the resident, while using little to zero non-renewable energy, is ideal in creating a sustainable, innovative, and contemporary structure that embraces both a flexible and efficient life style and, at the same time, addresses important energy issues that will be a solid foundation for a new modern world.

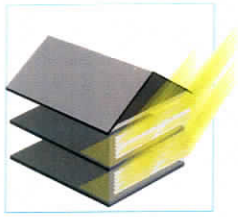
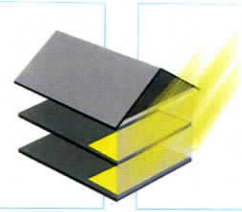
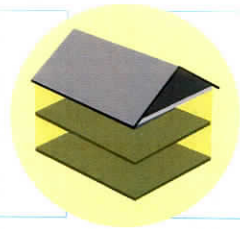
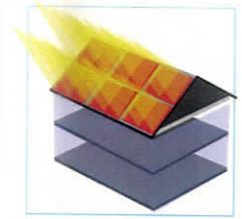
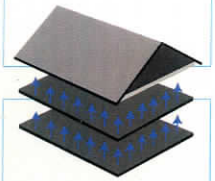
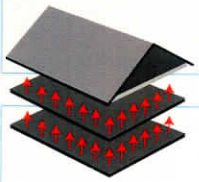
Passive mode design is the backbone for these principles and their integration into sustainable living. It is important to understand the climate of the locality to enable taking advantage of the ambient energies and climatic characteristics. My goal is to integrate specific passive systems into my built design for multi-family dwellings based on the conditions set by the urban site (Stamford, Ct.).

The underdeveloped land around the Stamford marina peninsula has the potential to become a catalyst for the inauguration of beneficial and innovative change. The historic marina, with its spectacular views and dynamic potential, provides the fertile foundation for the development of a beautiful modern housing development that both respects the conditions of the environment and embraces the future by creating a commuter friendly green community connected to the train station and rapidly developing central area of Stamford, Ct.

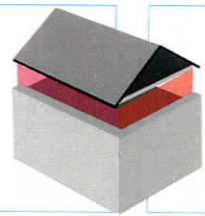
The parameters of the project would to be to investigate specific sites around the major transportation hub in Stamford, as well as other cities, to test the needs of different sites. Then to integrate the most suitable passive systems for the housing developments according to the climate and urban conditions. I would then proceed to look at the greater effects that housing would have on the commuter and for the community as a whole.

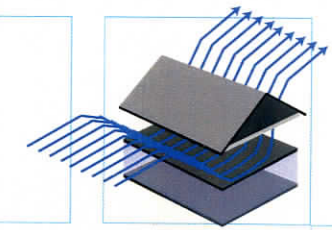
The scope of my project would be to do a series of studies taking advantage of different situations around the marina but inevitably encompassing one site. My testing would come from past precedents of eco friendly as well as transit oriented developments and the effects they both have on a city to see the ramifications or resolutions that occurred.

PART 2 SUPPORTING DISCUSSION FOR THESIS STATEMENT







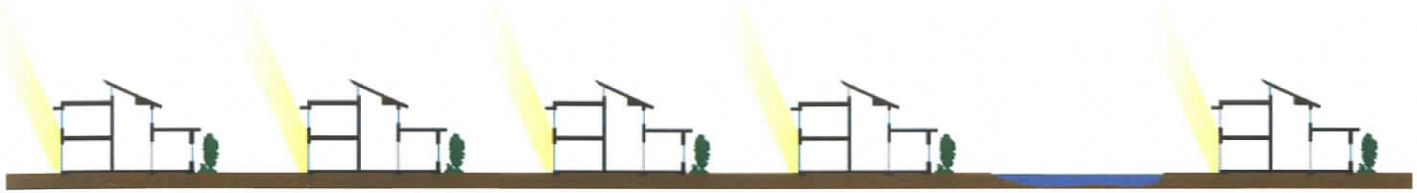
Ecodesign is the driving force of biointegration with the environment. Through this process ecodesign is innovative in blending harmoniously our everyday lifestyles and needs with "the larger pattern, flows and processes, and physical disposition of the natural world." Ecodesign carefully melds "our human-made systems with the natural systems and processes in the biosphere."

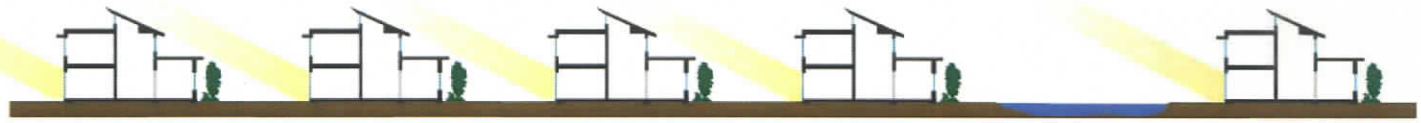
It is the vast parts and complex components that created the foundation of our modern "human made world." These vital systems are made up of structures, buildings, and the vast urban infrastructure, including roads, bridges, drainage systems, power grids, ports, etc. With our need to expand our industrial strength and create a world that meets our demands, we have further increased manufacturing and production, ultimately invading the natural environment. This beautiful ecosystem that dwells in the biosphere includes "all the biotic and abiotic constituents of the earth and the biospheric processes."[1] The main challenge presented with ecodesign is how to integrate construction and industry seamlessly with the natural environment. It is our human responsibility to achieve this very cooperative and beneficial relationship. If we can achieve this kind of quality design, it will certainly eliminate "virtually all the significant problems arising from the negative consequences of human activity on the natural environment."[1]

PART 2 **SUPPORTING DISCUSSION FOR THESIS STATEMENT**

ECODESIGN OBJECTIVE

[1] Yeang, Ken, Ecodesign: A Manual For Ecological Design. Great Brittain: John Wiley & Sons, Ltd, 2006.





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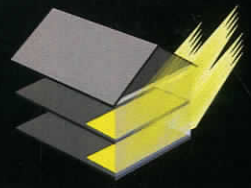


SOLAR ACCESS TO BUILDING

Sunlight is vital and a fundamental need for everyone. It is important that we harnest this "inexhaustible and environmentally friendly and freely available source of energy." This action of incorporating solar radiation and tapping into solar energy is the core from which sustainable architecture is created..

In developing a site plan, it is critical to address the reduction of heating loads in buildings. This is a primary consideration that will lead to the reduction of energy costs, which is vital in areas where heating cost are high. This is crucial to embracing a new green world that demands conservative measures to create a comfortable environment.

The important benefit of a very carefully envisioned site planning and building design will prove to be tremendously economical, reducing extra costs and later scales in colder regions where heating load is a dominant factor. It could also eliminate any need at all for mechanical heating systems in zones that have low heating requirements.

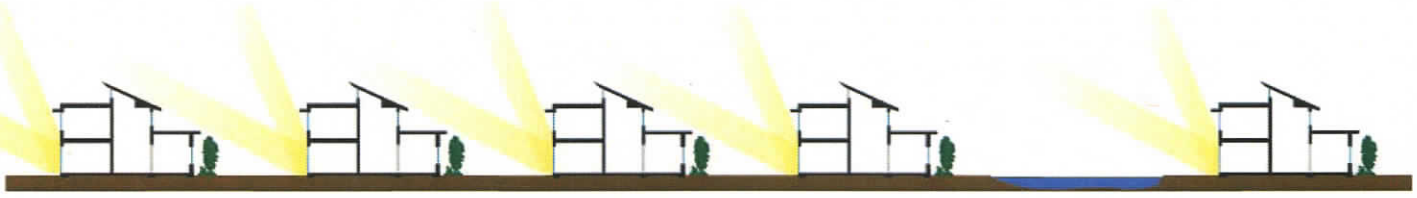
STRATEGIES

"To optimize site planning as regards to sunlight access, potential shade cast on the considered site by adjacent buildings, trees or topographical elements should be carefully defined.

To protect in turn adjacent buildings, streets and open spaces from undesirable shade, the amount of shade allowed must be carefully determined and taken into account.

Ensuring solar access to each building is the precondition for the use of solar energy in indoor spaces. Therefore, to maximize sunlight access, a buildings orientation and shape must be carefully determined in relation to its neighboring environment and particularly in relation to adjacent buildings.

As planning design requirements with regard to solar access are sometimes restrictive, architectural design strategies must be employed to ensure more compact developments."



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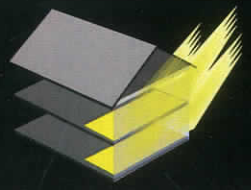


SOLAR ACCESS TO BUILDING

PROVIDING SUNLIGHT ACCESS TO ADJACENT CONTEXT

It is a designer's responsibility to make sound choices that will not jeopardize adequate sunlight provided to surrounding buildings. The height and position of a new building can have a serious effect on adjacent buildings, plus block daylight access and views for streets, parks, and open spaces.

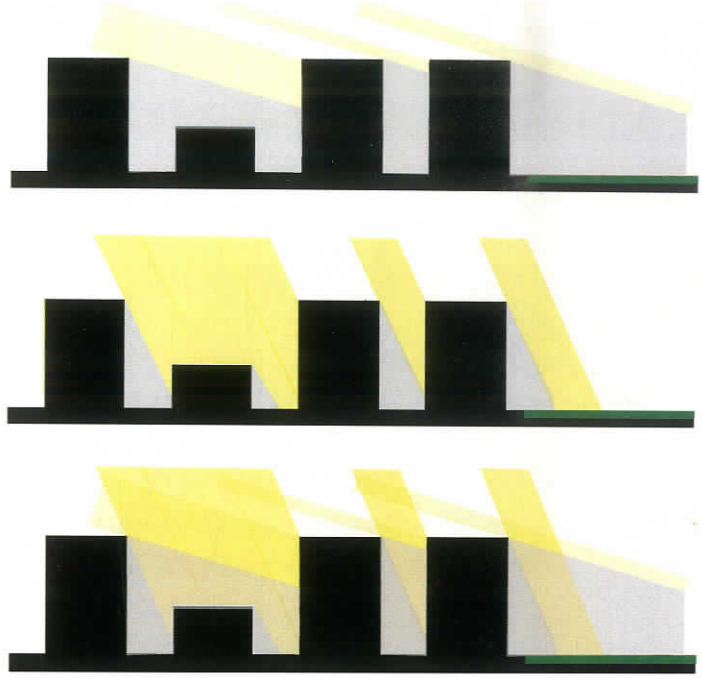
The usage of solar envelope design will help designers define exactly how much volume can be built without affecting the sunlight access to surrounding streets, parks, and buildings.

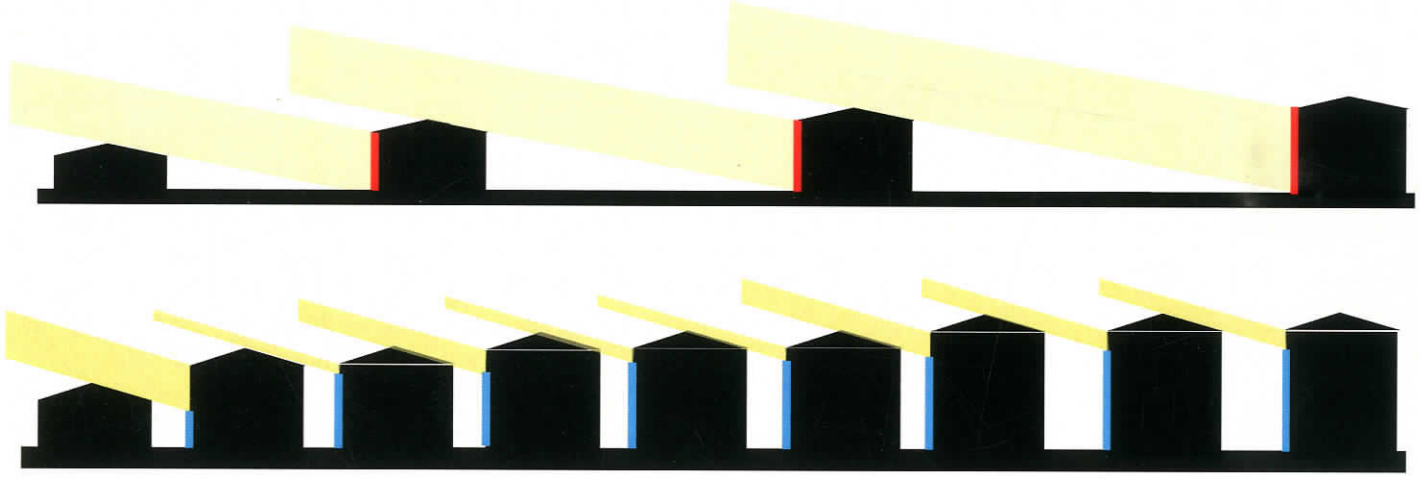
ADJACENT BUILDINGS CASTING SHADOWS

It is important to pick a site that is removed from too much overshadowing caused my large trees, adjacent buildings and hills because this will have a direct affect on the amount of solar radiation that is available. With site analysis recommendations, all potential shades that are cast must be carefully defined so that future buildings will not be positioned in shady locations.

Potential shade is seasonal and it is necessary to determine how it falls each day of the year, with an important focus on winter with the sun altitude being at it's lowest point.

The main obstructions that will create potential shades that have an effect on the site will originate from western, eastern and southern obstructions.





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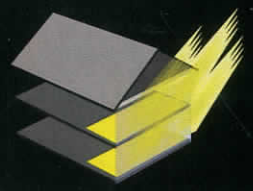


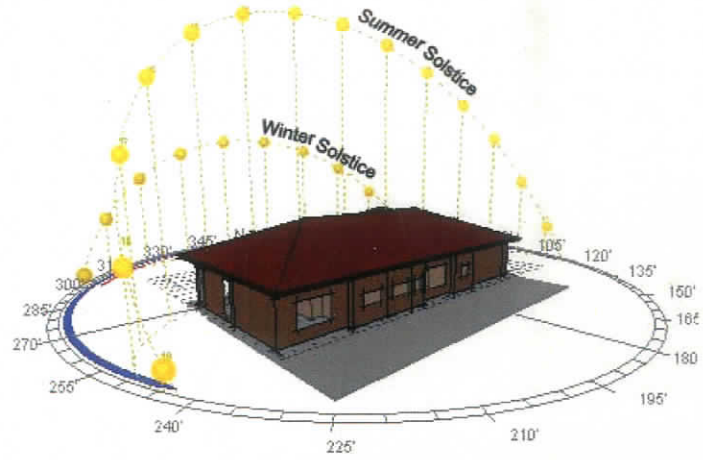
SOLAR ACCESS TO BUILDING

PLANNING OPTIMUM BUILDING ORIENTATION

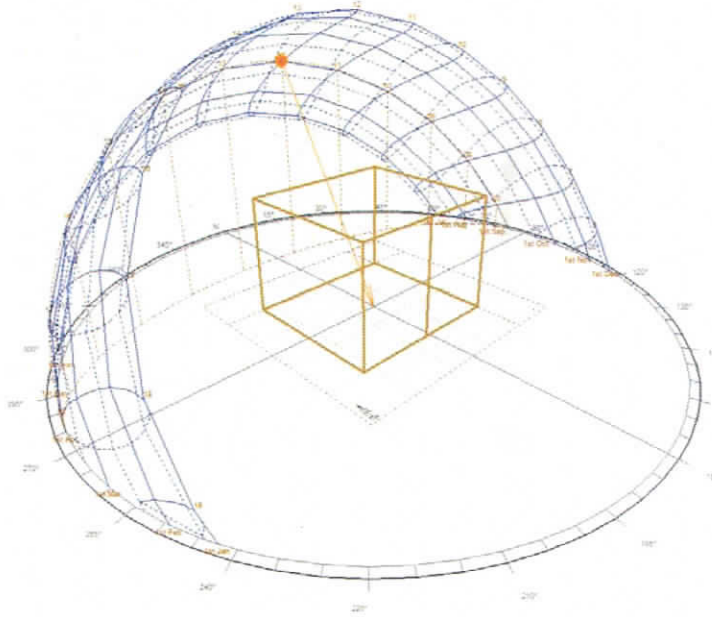
It is crucial to calculate the position of each building to maximize it's access to the sun's solar rays and to make sure it does not shade surrounding buildings. This will have a great impact on the architectural design and arrangement of each individual structure. This should correspond also to "the same principles as the solar envelope design applied to each and every building."

During the winter high solar gains can be achieved by giving the buildings a southern orientation. This will definitely apply to Stamford, Ct. where the heating load can become a dominant factor during the winter months. Nearby obstructions must also be taken into consideration when calculating the orientation of each principal façade.

Buildings should be spaced in north and south directions, allowing the solar energy to be absorbed by the lower levels, especially during the winter, adjusting to the sun's lower altitude and shorter daylight. The actual recommended spacing will be dependant on the latitude of, in this case Stamford, and the shortest time period which solar access is available.

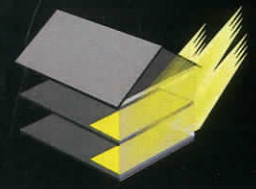


Solar Orientation Diagram
EcoTech [Diagram 1]



Solar Orientation Diagram
EcoTech [Diagram 2]

PART 2 **SUPPORTING DISCUSSION FOR THESIS STATEMENT**



SOLAR ACCESS TO BUILDING

OPTIMAL SITE AND SHAPE FOR THE HOUSING UNITS WITHOUT COMPROMISING SOLAR ACCESS.

Using different planning and architectural design methods, more compact developments can be achieved. This will allow a higher density with construction, and a reduction of spacing between buildings.

South-facing slopes create sites which allow a greater decrease in the spacing between buildings because they will be receiving more sun, especially during the winter with the sun's altitude low in the sky. Those buildings that stretch form east to west will need to be closer together than on a flat site so that they do not compromise "solar access to the south facades."

"The development density can be increased by gradually increasing building heights in the north direction. Taller buildings should be placed to the north in order not to overshadow less tall ones.

The advantage of south facing slopes can be recreated by installing at ground level on the north side of buildings, indoor spaces that do not require as much solar access as dwellings.

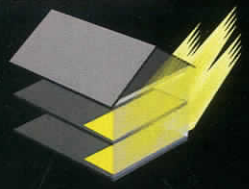
The volume of each building can be maximized by adapting its shape to the maximum volume determined by the solar envelope design in accordance with low winter sun angles.

The buildings height is thus lower on its north side than on its south side the design devise allows more potential solar gain on the south side and protects sun access to the building located on the north by respecting the required spacing, while allowing for more compact development. "[1]

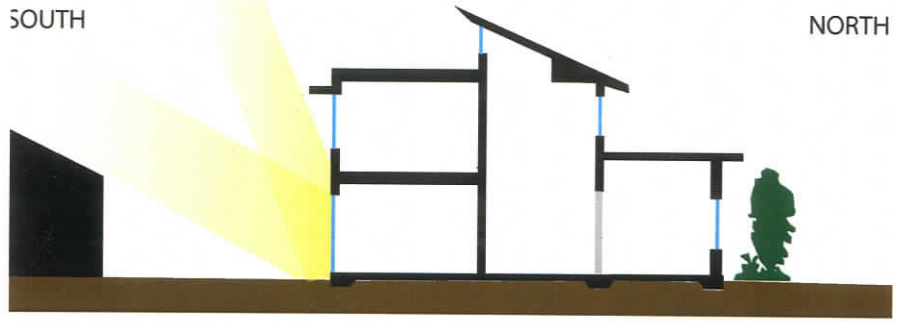
Case Study: Housing Estate in Kolding, Denmark
Architects: 3XNielsen, Arhus
Lars Frank Nielsen, Kim Herforth Nielsen

[1] Salat, Serge, ed. The Sustainable Design Handbook CHINA. China:Tsinghus UP, 2006.

PART 2 **SUPPORTING DISCUSSION FOR THESIS STATEMENT**



SOLAR ACCESS TO BUILDING



PROVIDING DAYLIGHT ACCESS TO BUILDINGS

To provide strong natural light inside the buildings, it is important to pay close attention to daylight access. This is very dependent on the location of the site. "This the provision of natural light inside dwellings required firstly optimized building and open spaces planning to ensure adequate daylight access for each building."[1] The actual orientation and spacing of each structure must be carefully planned.

Artificial light not only requires the usage of electricity and raises the costs of operating a home, but it also simultaneously building up pressure on the environment. In contrast natural sunlight is free and unexhaustable.

Daylight availability outside is far greater than the light required inside buildings. "For example, an over sky provides an average of approximately 10,000 lux which can be utilized for lighting the indoor spaces."[1]

The efficiency of natural daylight provides incredible savings in energy use contrasted with that of artificial sources, such as electricity.

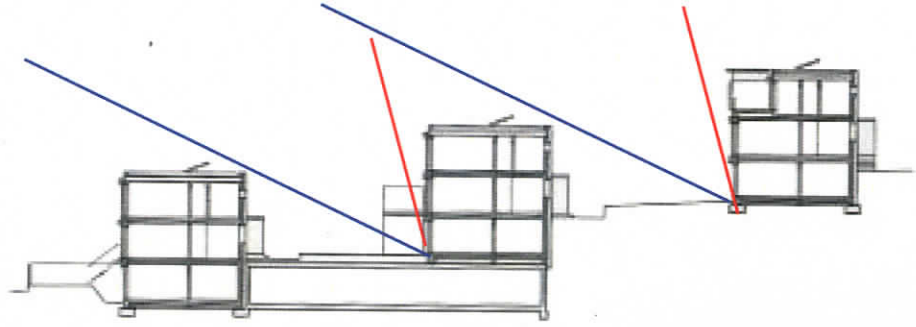
STRATEGIES

"The use of solar radiation for lighting, which offers sizable advantages in terms of occupant health and well-being, requires a carefully thought-out planning design. Daylight availability must therefore be taken into consideration from the very beginning of the design stages, particularly in dense urban areas.

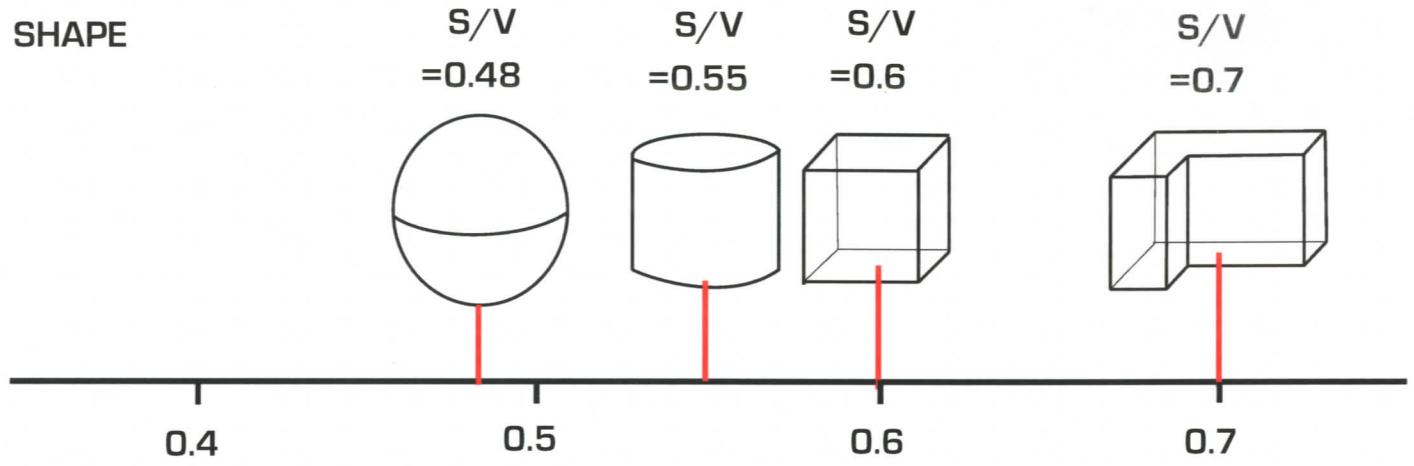
In addition to climatic conditions, previously identified at the site analysis stage, the location of a building or group of buildings in its immediate environment plays an important role as refgards daylight availability. Shading from neighboring buildings or trees, as well as orientation, influences the amount of daylight available on the site and thus inside buildings.

Daylight obstructions induced by the buildings to be built must in turn be carefully defined in order to protect adjacent sites from overshadowing and to optimize building planning as regards daylight access at the site scale."[1]

Passive-Energy Terraced Housing in Ulm, Germany
Architect: Johannes Brucker



[1] Salat, Serge, ed. The Sustainable Design Handbook CHINA. China:Tsinghus UP, 2006.



PART 2 **SUPPORTING DISCUSSION FOR THESIS STATEMENT**

DESIGN STRATEGIES

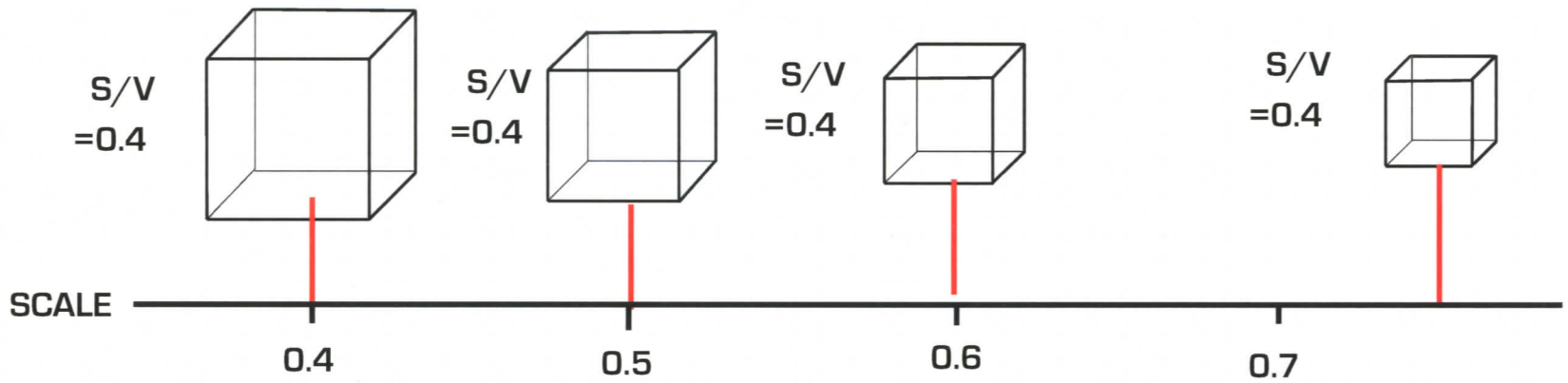
BUILDING SHAPE

When determining the ideal effective and functional shape of the building, the aim is to figure out a way to insulate or minimize undesirable heat exchanges between outside and inside. To maximize energy efficiency, there are several design strategies to focus on.

SURFACE-TO-VOLUME RATIO (S/V ratio)

Heat exchanges are very dependent on the envelope area, especially in regions that experience severe weather, such as Stamford, Ct. So it is important to expose as little surface area per volume as possible. "One useful value in determining an optimized building form is the S/V ratio, which expresses the relationship between exposed surface area of a building and its volume."

Sustainable buildings tend to have a low surface-to-volume (the amount of surface a structure has relative to its size) ratio to support their energy efficiency. This will also prove to be financially economical and with the usage of less energy for its construction. "Capital and operating energy tend to increase as the S/V ratio increases."



PART 2 **SUPPORTING DISCUSSION FOR THESIS STATEMENT**

DESIGN STRATEGIES

ASPECT RATIO

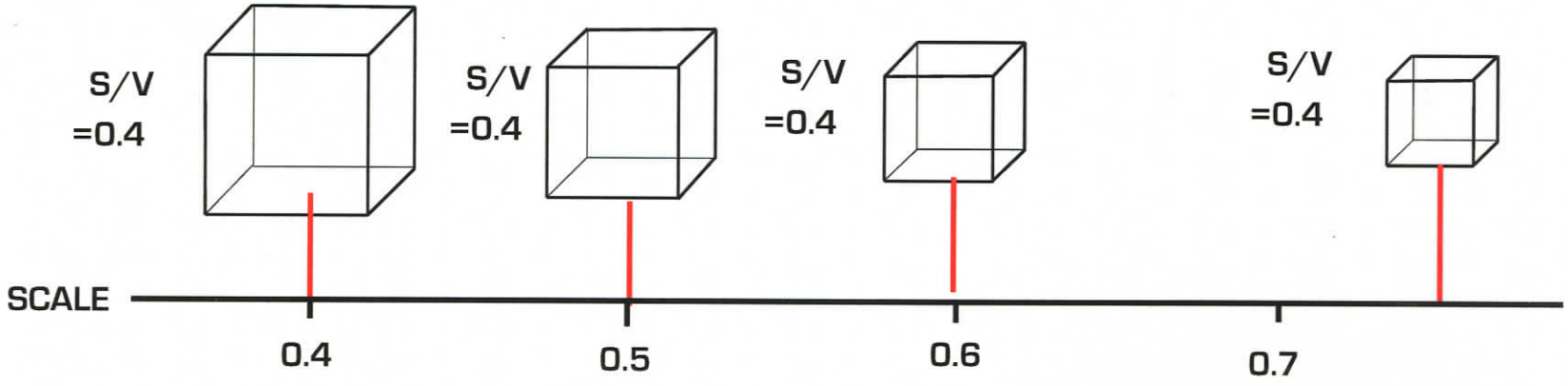
The shape of a building needs to be optimized in order to create maximum solar gain. This can be achieved by making sure it is "elongated along its east west axis so as to maximize the south facing façade." Creating this kind of shape in most climate areas allows for easier passive control of solar energy.This holds true in cold climates, such as Stamford, Ct. Incorporating an increase or elongated south-facing façade, the structure's energy efficiency will be optimized through its usage of solar radiation.

Whereas in hot climates when the sun is at its highest position as it moves southward, it will be easier to protect the building from excessive heat gains with better control of the sun rays."A good aspect ratio is 1.3 to 2.0

SCALE:

It much more efficient to group small structures together to create dense and compact buildings than to have detached buildings, free standing structures with the same mass proportion. "the amount of exposed surfaces decreases as the number of shared enclosing surfaces is increased." Having attached units creates more efficiency than detached houses "because only two walls (three for the end units) instead of four are external." Rowe housing is a good example of this. Units that are grouped in apartment buildings are examples of further reduced amounts of exposed surfaces.

It is important for the designer to keep in mind that architectural quality could be compromised by following very restrictive S/V ratio and scale criteria. This disadvantageous building geometry must be further developed through the usage of solid solar control or improved insulation, including making sure the design functions "well within the specific conditions set by the local climate in accordance with the comfort requirements for the building."

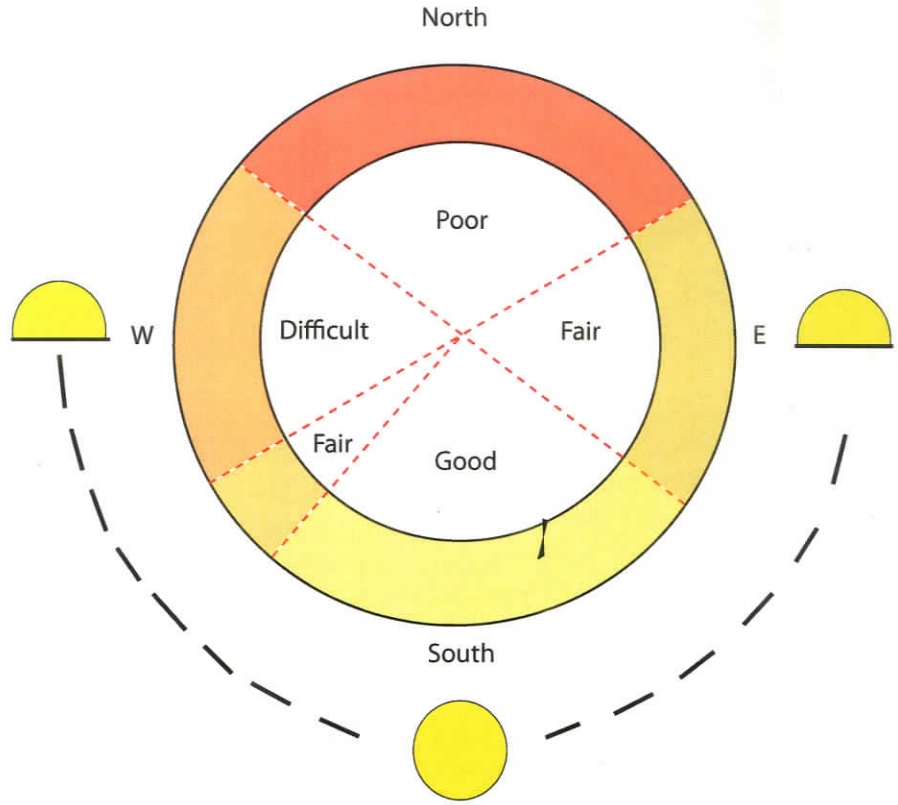


PART 2 **SUPPORTING DISCUSSION FOR THESIS STATEMENT**

PASSIVE SOLAR HEATING

Passive solar radiation energy is the main focus and fundamental to sustainable architecture. To make use of the free and environmentally friendly solar energy, the design of a building achieves this through shape, design, orientations, components and materials.

The proportion of annual heating which a sun supplies is figured out by the balance between the rate of heat lost in a building and the quantity of solar radiation that is collected. "The main objetive in passive solar heating is thus to minimize heat loss while maximizing heat gains."[1]



A major issue issue is to figure out how to minimize heat loss. Air infiltration and conduction needs to be minimized. At the same time, "Maximizing heat gains requires the use of passive solar heating systems which we had on the collection, storage and distribution of solar energy available on the considered sites."[1]

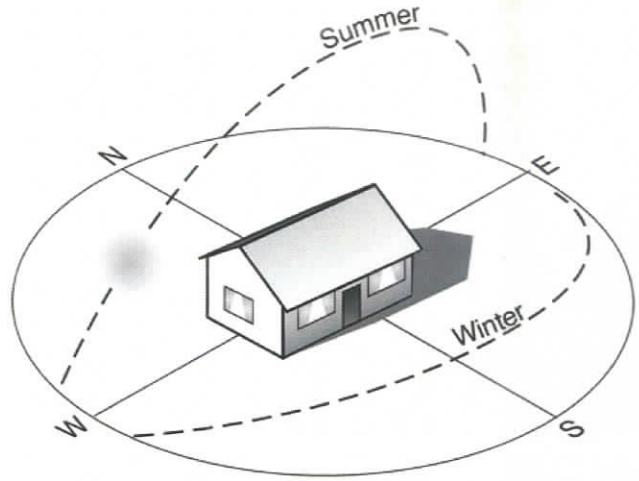
The demand for heat and the length of the heating period can be reduced considerably, through the use of passive solar heating systems. This will reduce the technical heating requirements with little first costs, if any at all. For mild climates the use of passive solar heating systems will provide adequate heating needs, even during the coldest periods. With this reduction of the need for any mechanical heating needs, passive solar heating systems will allow a very notable decrease in the usage of fossil energy, with the added benefit of making a significant reduction of CO2 admissions.

[1] Salat, Serge, ed. The Sustainable Design Handbook CHINA. China:Tsinghus UP, 2006.

PART 2 **SUPPORTING DISCUSSION FOR THESIS STATEMENT**

PASSIVE SOLAR HEATING FUNDAMENTALS

How well passive solar heating systems performs is directly correlated to two important facts, which are how much solar radiation is collected and what the thermal storage capacity is.



Solar Orientation Diagram
EcoTech [Diagram 3]

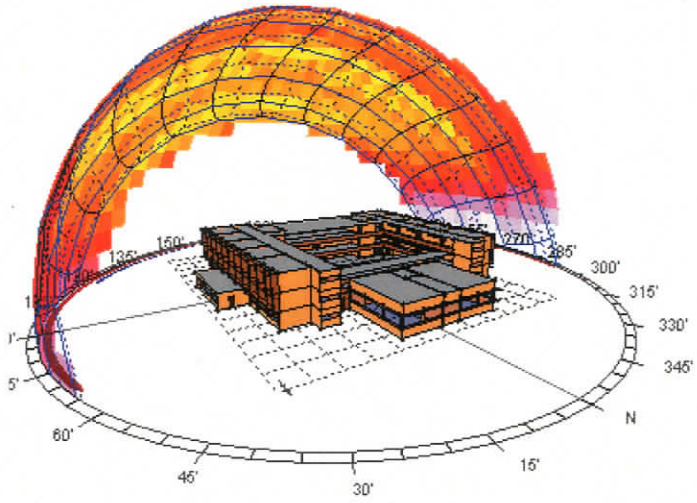
SOLAR RADIATION AVAILABILITY

Even during the coldest time of year, passive solar heating systems do require as much direct or diffused solar gains as possible.

BUILDING ORIENTATION

Winter's most intense solar radiation occurs at noon. Before and after that high point there is a big drop off. Logically as the sun during the winter is at a low angle, it is the more south facing surfaces that will benefit from the greatest gain of solar radiation.

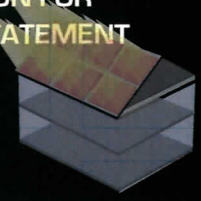
Even with a southern orientation achieving the best collection of solar radiation, there is a flexibility of up to 30 degrees west or east of south that also gets quite a bit. "Given the fact that declination from south and performance follows a non-linear process, it is usually assumed that, within the range, the performance decrease is less than 10 percent of the optimum."[1] Because the collection of solar radiation is intended for storage purposes in order to be released at night, it goes to show that orienting structures a few degrees west of south is a good thing to do because this will in effect minimize the overall time lag between heat gain and heat release.



Solar Radiation Diagram
EcoTech [Diagram 4]

[1] Salat, Serge, ed. The Sustainable Design Handbook CHINA. China:Tsinghus UP, 2006.

PART 2 **SUPPORTING DISCUSSION FOR THESIS STATEMENT**



PASSIVE SOLAR HEATING FUNDAMENTALS

OVERSHADOWING

Keeping these general rules in mind, the best orientation for a building location should be determined and adjusted based on the actual site characteristics. In early planning stages, it is important to take note of any neighboring buildings that may cause overshadowing during the most crucial 9 am - 3pm time frame. This will cause a shifting in orientation to find an area on the site that is least obstructed from this crucial time of day.

PASSIVE SOLAR HEATING STRATEGY

COLLECT: Solar radiation collection should be optimized by the correct orientation of the building, the proper sizing and placement of windows, and efficient glazing.

STORE: Heat should be retained and stored in thermally massive building elements before being released when needed.

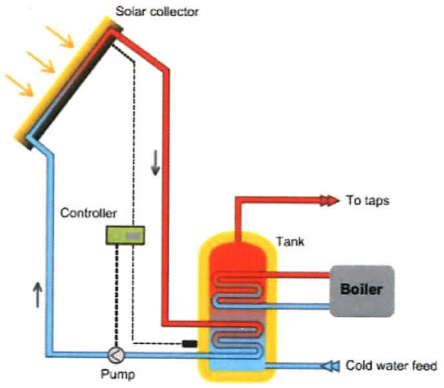
DISTRIBUTE: Stored heat should be released when needed using natural heat-flow exchanges.

PART 2 **SUPPORTING DISCUSSION FOR THESIS STATEMENT**

SOLAR THERMAL SYSTEMS

OBJECTIVE

There is a distinct difference between using passive methods to utilize thermal power from the sun and active systems that acquire the solar gain. These active systems by nature are more active and actually turn the direct solar radiation a new kind of energy. With solar collectors the water is preheated with the usage of closed circuit elements.



DESIGN ENERGY EFFICIENCY

There exists numerous methods for increasing building energy efficiency:

SPECIAL GLASS

This can be used to maximize the daylight sun and reduce the need for interior lighting. It also manages to keep ultraviolet rays and heat out and also has the benefit of reducing heat loss during the winter.

NATURAL GAS POWERED FUEL CELLS

These are capable of supplying power that will last all night. It also utilizes the hot water exhaust produced by the fuel cells to give the building heat and hot water.

HEATING AND COOLING SYSTEMS

Rather than using electricity these could be gas powered, reducing the energy losses that electric power transmissions suffer from.

PHOTOVOLTAIC PANELS

Additional power can be provided by these panesl

MOTION SENSORS

These can control the fans and light switches where there is less activity going on inside the building, such as in stairwells and certain hallways. This could actually lower the energy consumption 35-40% than a comparable conventional building..

Natural lighting and ventilation are used in green buildings wherever possible. The main façade could consist of a double layer of glass which encloses a ventilated cavity that possesses computer controlled blinds. Using a system of weather sensors outside the building could help monitor the actual temperature, level of sunlight, and even wind speed. Reacting to these factors it could activate the closing and opening of the window panels to further facilitate efficient usage of energy. How the building shape is designed will maximize the usage of natural daylight and reduce the requirement for any kind of artificial lighting.

ADVANTAGES

Passive solar heating, cooling and lighting techniques have reached a high degree of technical maturity. Large scale applications have shown that very high energy gains can be achieved while thermal and visual comfort and indoor air quality are very satisfactory.

The application of passive solar techniques coupled with energy efficiency systems leads to important energy and environmental benefits, such as more attractive daylight interiors, less dependence upon mechanical systems, fewer ozone depleting refrigerants, lower energy and maintenance costs, a good long term investment with less dependence on supplies of delivered energy, less overheating, more comfort and a healthier internal environment. Active solar systems are the most widespread type of renewable energy sources system.

PART 2 **SUPPORTING DISCUSSION FOR THESIS STATEMENT**

NATURAL VENTILATION

The very important role that ventilation plays in buildings is improve the air quality by maintaining good levels of oxygen in the air. It also is vital to remove moisture, odor, and internal pollutants. It can also by utilized to get rid of any excessive heat through air conditioning or by using the thermal mass of the building itself. With performance criteria, ventilation is related to how much air quality control and thermal comfort exist in a building.

AIR QUALITY CONTROL

By using ventilation rates or controlling the contaminant concentration, air quality can be greatly improved. Minimum ventilation rate is the method that is most often used when designing natural and mechanical ventilations systems.

THERMAL COMFORT

There is proof that the criteria for thermal comfort varies from naturally ventilated buildings contrasted to air-conditioned structures. When given the opportunity to actually control one's environment, individuals tend to adjust to the seasonal differences easier. Thus, when natural ventilation is used there is a tendency to have a broader variation for indoor air temperature. Natural or hybrid ventilations will increase the range when it is used for night cooling of a building's thermal mass. This is happens because the mean radiant temperature of wall surfaces will make indoor air temperature drop.

The mean behavior pressure loop method is what ventilation rates and component sizing are based on. "The performance criteria for ventilation may be formulated in terms of ventilation rated, air quality or thermal comfort."[1] These ventilation rates are an important part of the actual ventilation design.

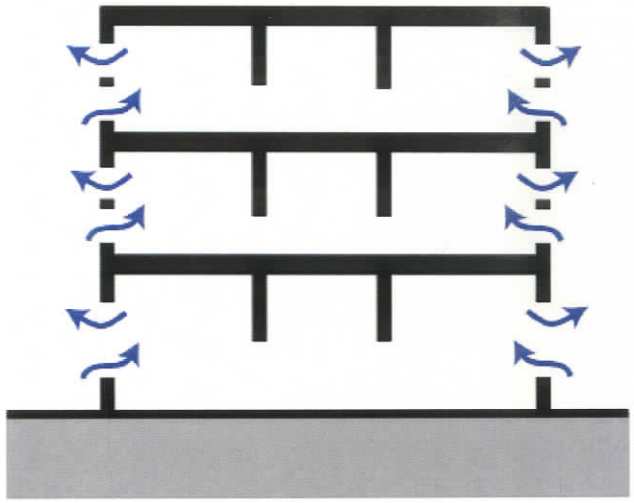
[1] [1] Salat, Serge, ed. The Sustainable Design Handbook CHINA. China:Tsinghus UP, 2006.

PART 2 **SUPPORTING DISCUSSION FOR THESIS STATEMENT**

NATURAL VENTILATION

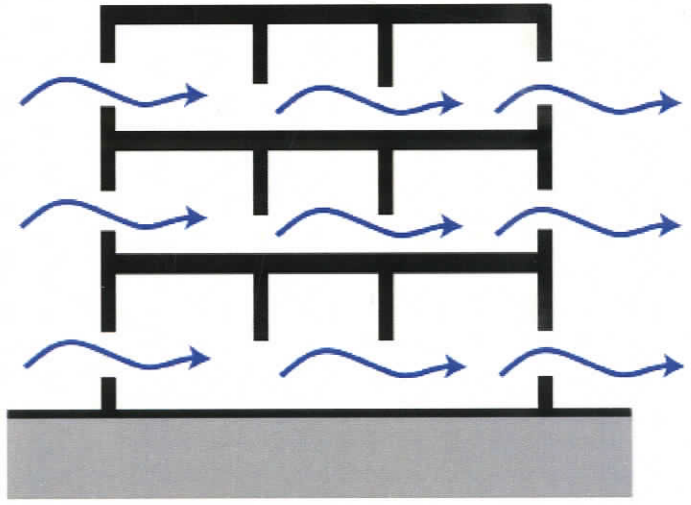
WIND VARIATION-INDUCED SINGLE SIDED VENTILATION

To achieve wind variation-induced single sided ventilation you would leave a window open in what would otherwise be an air tight room, to create a flowing current of fresh air. Wind and buoyancy induce this air flow through the opening. This buoyant, fluctuating movement from the wind may vary as it pours over the opening, creating a literal "pumping effect." [1] This can be explained by the heavier cold air from outside enters the room low, as the warmer air from inside the room exits through the upper section of the opening. During the warmer months of the year this single sided ventilation would not be as effective due to the the air remaining the same temperature inside and out. There would not be the fluctuating air exchange from both pouring in and flowing out. The air would remain more constant.



CROSS VENTILATION

The shape of a building and the urban environment both contribute to how effective cross ventilation systems are at contributing to the air exchange to the floor for a building. "Wind air-flow over building tends to induce positive pressures on windward surfaces and negative pressures on leeward surfaces, thereby creating a net pressure difference across the section of a building that drives cross ventilation air flows." [1] When air flows into the building on one side and crosses over the indoor space, exiting the structure on the another side, two sided or cross ventilation has been achieved.



[1] Salat, Serge, ed. The Sustainable Design Handbook CHINA. China:Tsinghus UP, 2006.

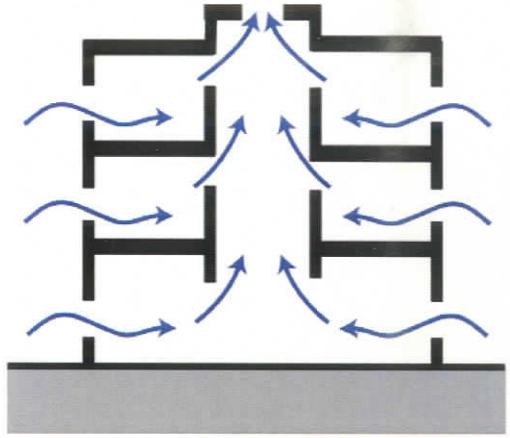
PART 2 **SUPPORTING DISCUSSION FOR THESIS STATEMENT**

NATURAL VENTILATION

BUOYANCY DRIVEN STACK VENTILATION

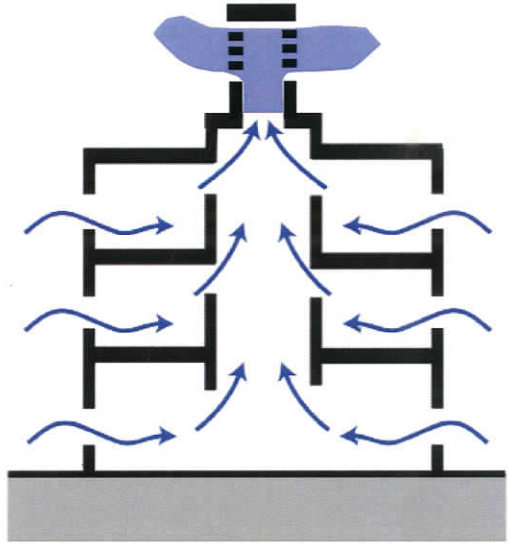
Stack ventilation systems maintain buoyancy and crucial ventilation overall, and are very dependant on the actual form and layout of the rooms. While lighter warmer air tends to move up and flow steadily out of upper level exhausts, the cooler air from outside will flow in through the lower level inlets to replace it. Building height and contrasting temperature variation between outdoors and indoors will determine the amount of driving pressure stack.

"For a three-storey building about 10m high, the difference between indoor and outdoor temperatures should be about 23 degrees in order to obtain a pressure difference of approximately 10 Pa, typical for wind-driven pressure."



SOLAR VENTILATION

When buoyancy pressure resulting from the difference between the internal and the external temperatures is not sufficient solar induced ventilation can be an alternative. The principle is to increase the stack pressure by heating the air in the ventilation stacks resulting in a greater temperature difference than in conventional systems. The principle of the solar collector may be used for different types of devices, Trombe walls, double facades, solar chimneys or solar roofs.



WIND AND BUOYANCY-DRIVEN VENTILATION

When properly designed, stack ventilation systems use both wind and buoyancy-driven pressure differences. This system is similar to stack ventilation but with a stack terminal device added that can respond to prevailing wind direction to maximize the negative pressure induced by the wind.

[1] Salat, Serge, ed. The Sustainable Design Handbook CHINA. China:Tsinghus UP, 2006.

PART 3 DOCUMENTATION AND ANALYSIS OF PROGRAM

1 BEDROOM UNITS

Foyer
Kitchen
Dining Room
Living Room
Bedroom
Bathroom
½ Bathroom
Closet Space
Terrace

2 BEDROOM UNITS

Foyer
Kitchen
Dining Room
Living Room
2 Bedrooms
2 Bathrooms
½ Bathroom
Closet Space
Terrace

Program Statement:

The philosophy and goal of creating a Sustainable housing community through the utilization of passive and active systems is to introduce a better way of living for the every day commuter. The housing will be made up of a combination of 1 bedroom and 2 bedroom apartments. Each single bed room unit will have a gross internal area of approximatily 960 sq/ft while the 2 bedroom apartments will have a gross internal area of approximately 1200 sq/ft.

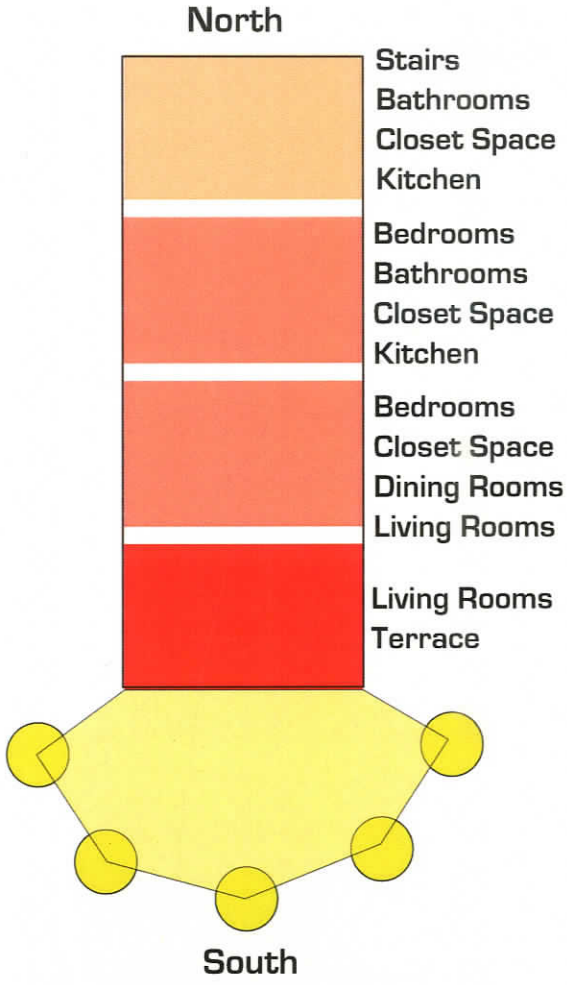
INTERNAL ZONING FOR THE APARTMENTS

The spacing out of rooms within the housing apartments should be based on the principle that some rooms have different temperature requirements then others.

Also the measurement of activity, whether it be sedentary or active and the time in which they are occupied, is essential to the layout of spaces.

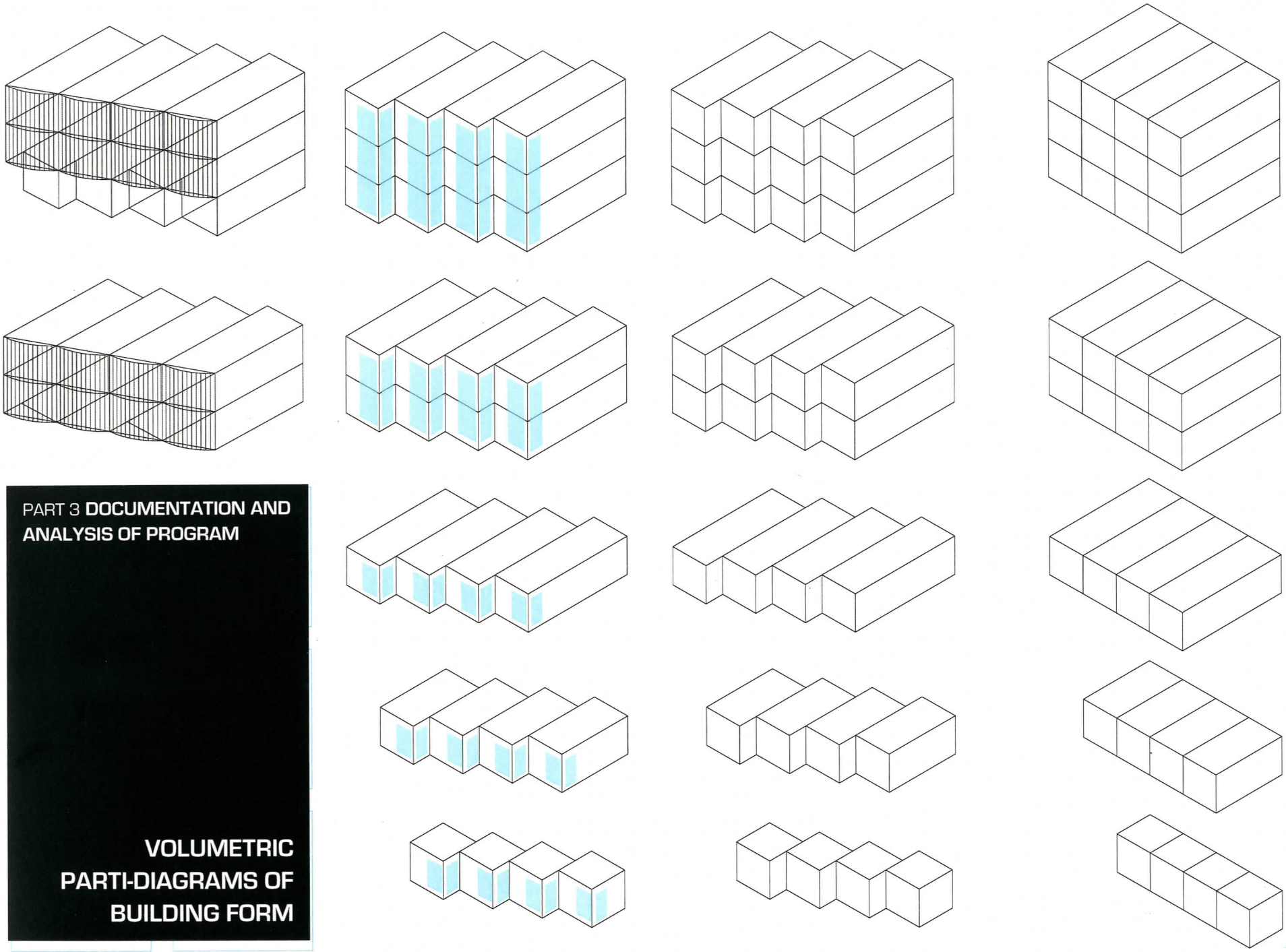
Dwellings located in areas where the heating load is the dominant factor, rooms having the highest heating requirements, such as living rooms, should be located on the south-side of the building in order to benefit from direct solar radiation. The northern facades on the other hand should be fronted by rooms that do not require as much heat, such as storage spaces, bathrooms and kitchens, as more continuously occupied spaces.

A good method to help this process is to use buffer spaces to protect rooms with specific temperature requirements. Areas characterized by the same temperature requirements should have the most beneficial orientation and should be grouped together. Buffer spaces should be used to protect these beneficial spaces from less favorable temperature conditions. Circulation and storage areas should be located in order to protect spaces that need careful temperature control.



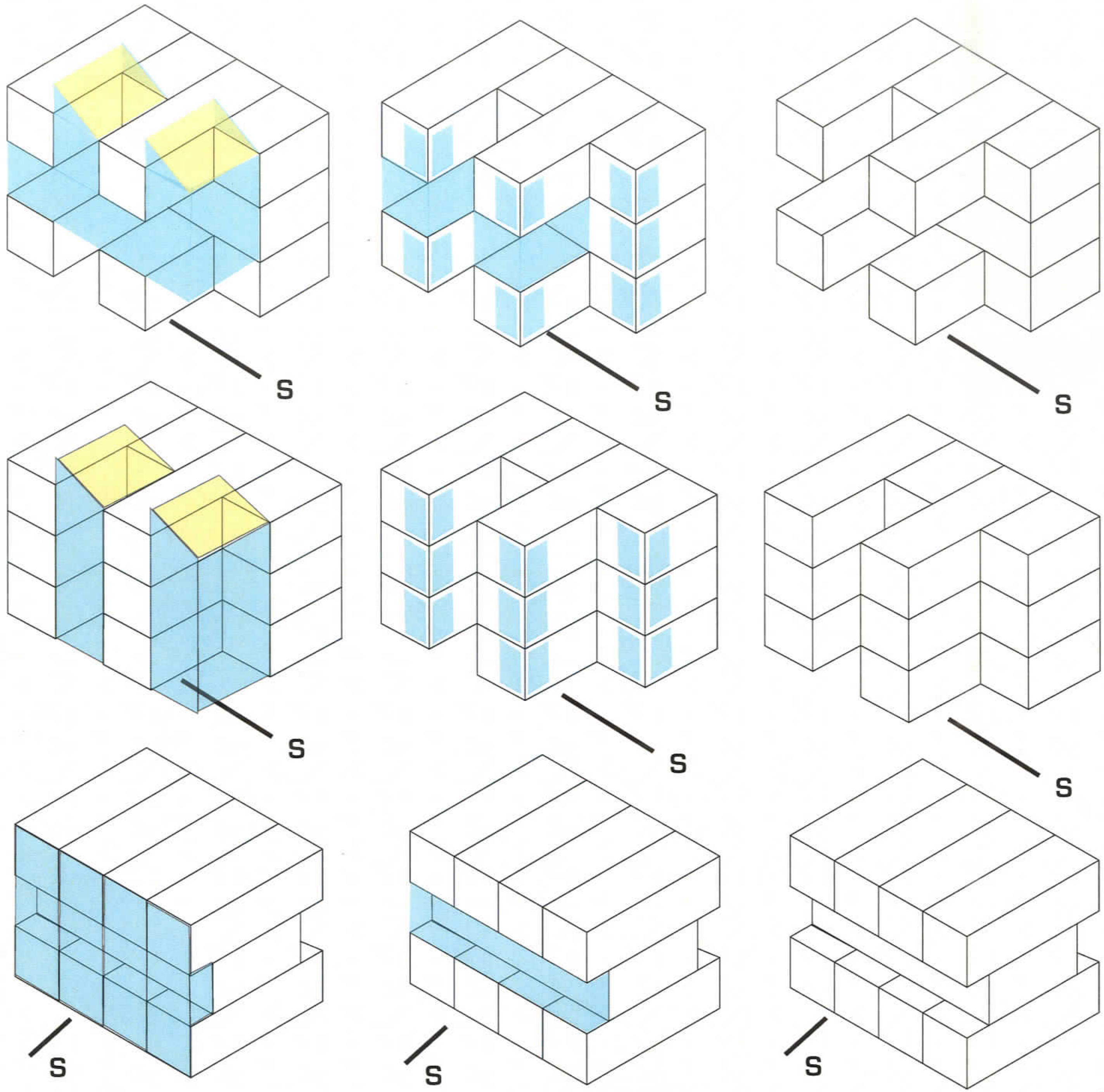
PART 3 **DOCUMENTATION AND ANALYSIS OF PROGRAM**

VOLUMETRIC PARTI-DIAGRAMS OF BUILDING FORM



PART 3 **DOCUMENTATION AND ANALYSIS OF PROGRAM**

VOLUMETRIC PARTI-DIAGRAMS OF BUILDING FORM



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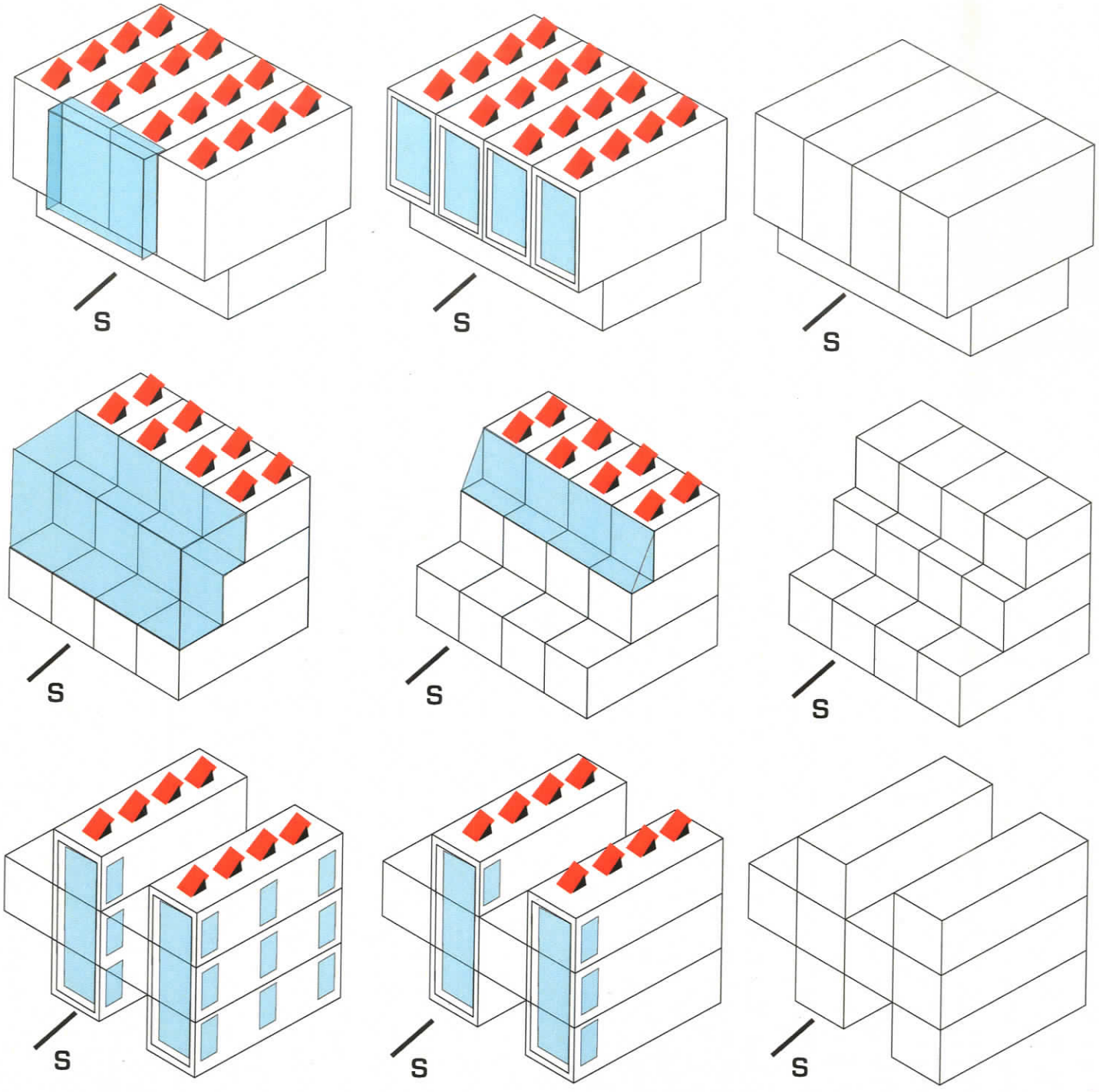
VOLUMETRIC PARTI-DIAGRAMS OF BUILDING FORM



PART 4 DOCUMENTATION AND ANALYSIS OF SITE

City Analysis Diagrams

CONNECTIONS TO CITY

RESIDENTIAL

COMMERCIAL

CONTEXT

TRAIN STATION/I-95

City Analysis Diagrams

The site is less then half mile away from the Stamford train station which makes it an optimal location for a commuter.

SURROUNDING CONTEXT

PARK

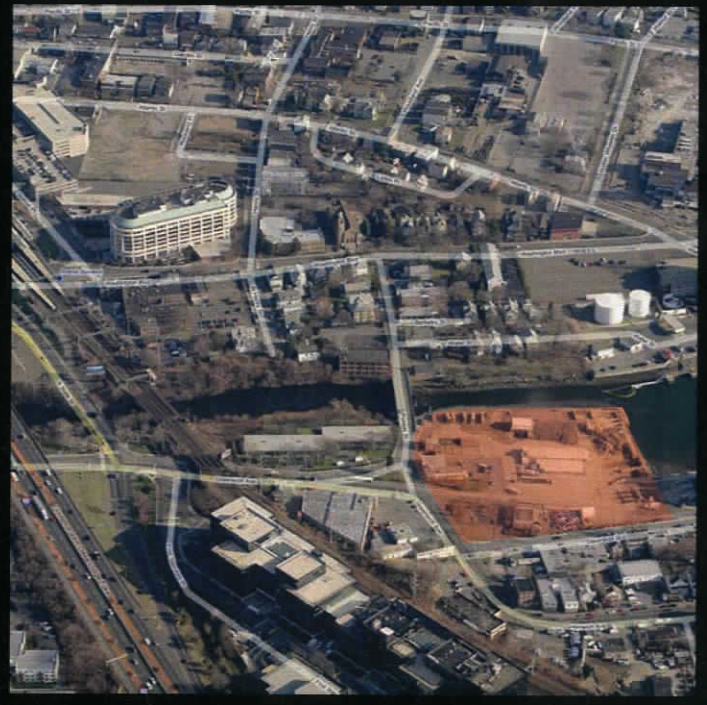
CONNECTION TO TRAIN STATION

NEW DEVELOPMENTS

Site Documentation

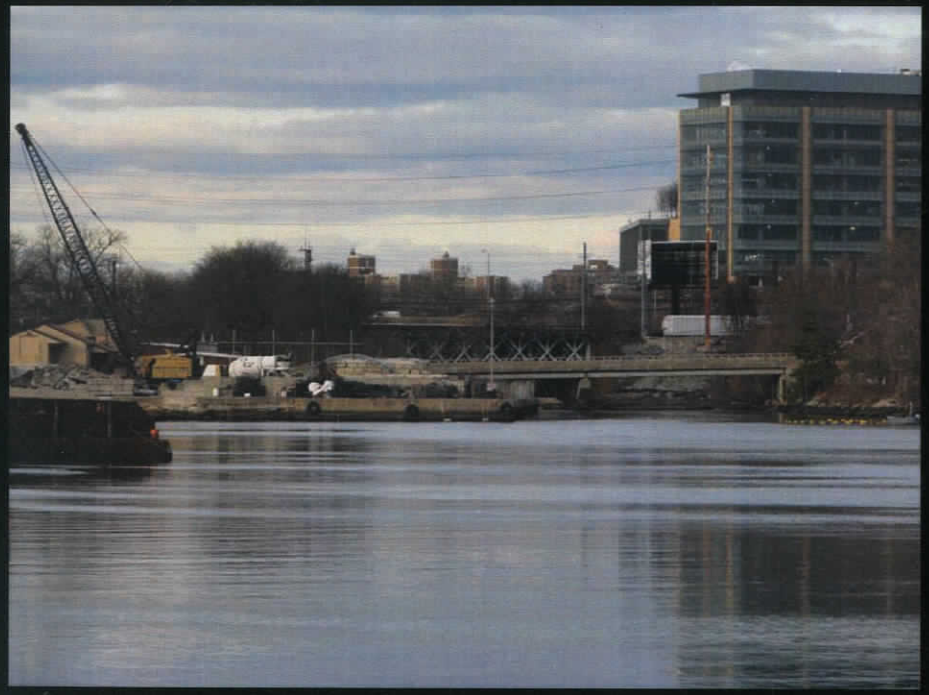
Views of the site looking from north, south, east and west. Currently the site is occupied with a sanitation and recycling center. By taking this away and implementing the sustainable apartments, would create a connections between the residiential neighborhoods to both sides of the river.

The position being right on the river allows for no obstuctions to be affecting the site from the south, allowing for the maximum solar gain to be given to the built form



PART 4 DOCUMENTATION AND ANALYSIS OF SITE

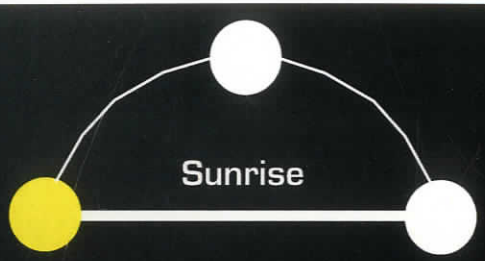
Site Documentation

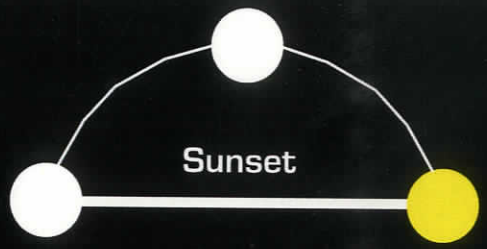


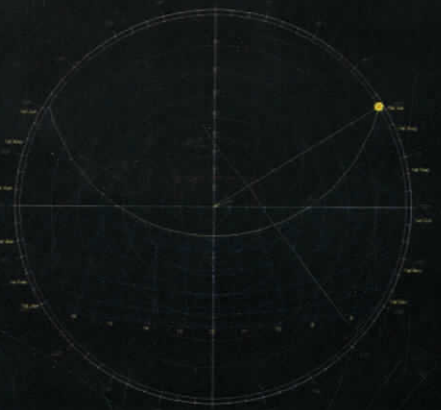
PART 4 DOCUMENTATION AND ANALYSIS OF SITE

Climate Studies of Stamford, Ct

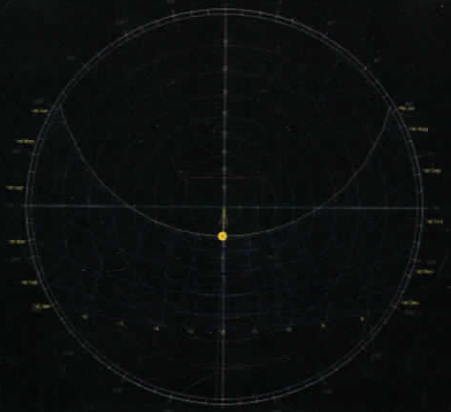
Sun Exposure for Summer Solstice and September Equinox for Stamford C.T.



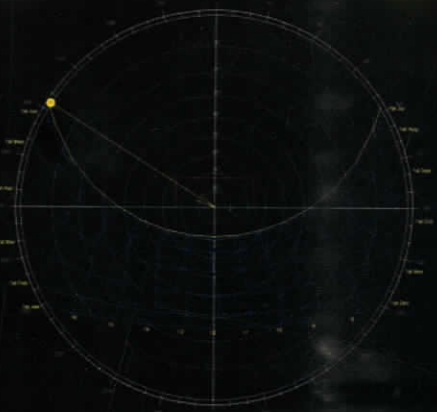




June 21 0430 Am



June 21 1200 pm



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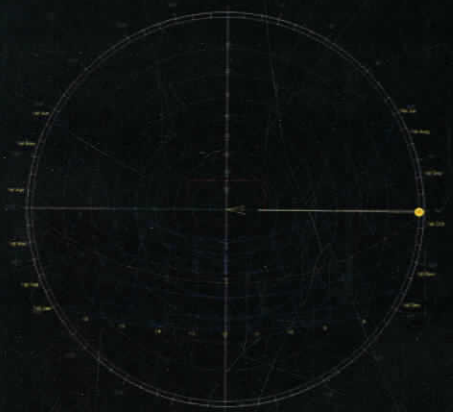
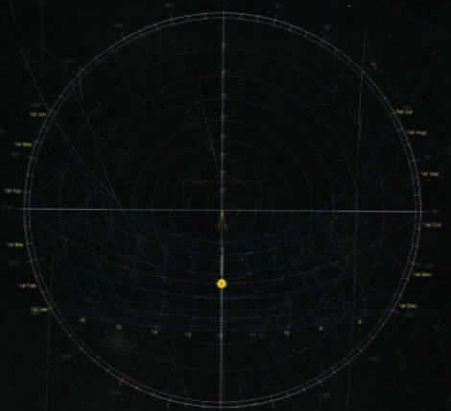


Sept 21 0545 Am



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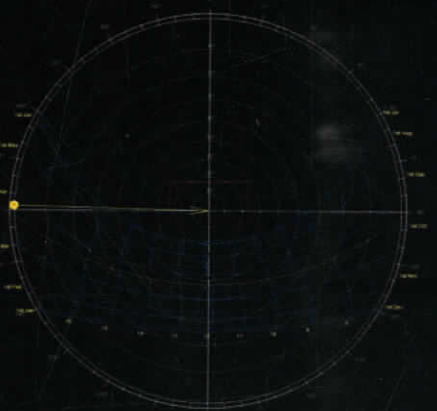
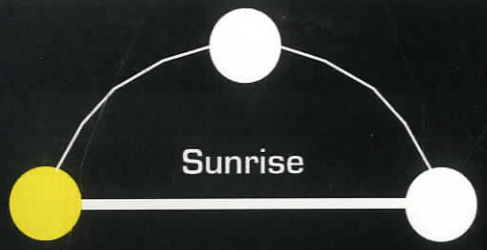
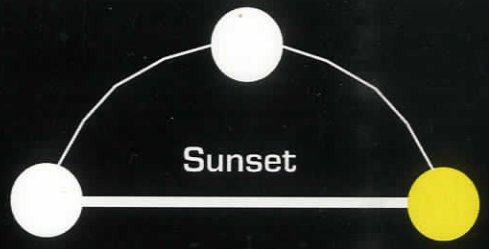


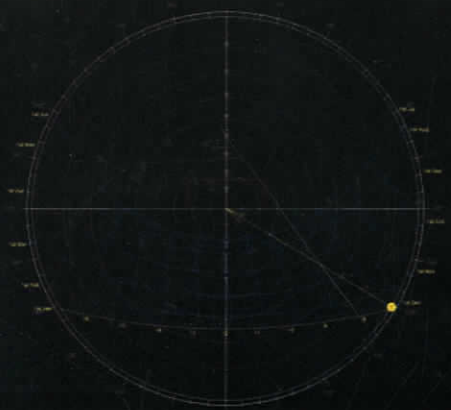
Sept 21 1800 pm

Climate Studies of Stamford, Ct

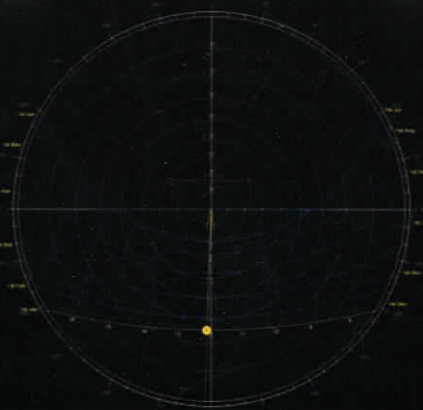
Sun Exposure for Winter Solstice and March Equinox for Stamford C.T.







Dec 21 0715 Am



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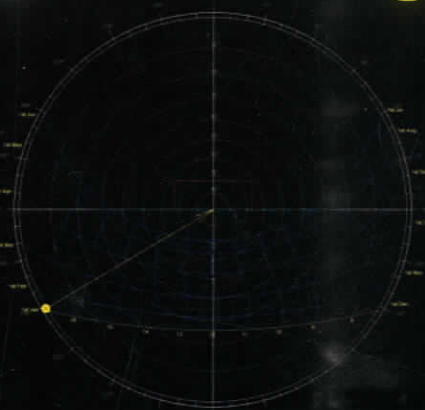

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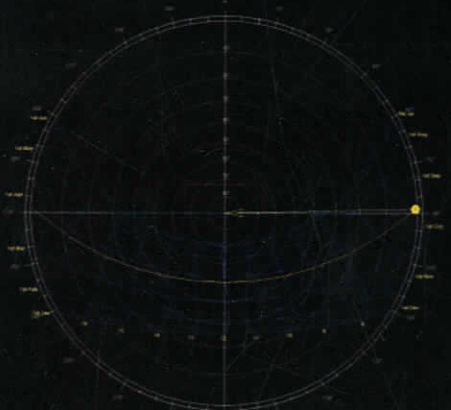
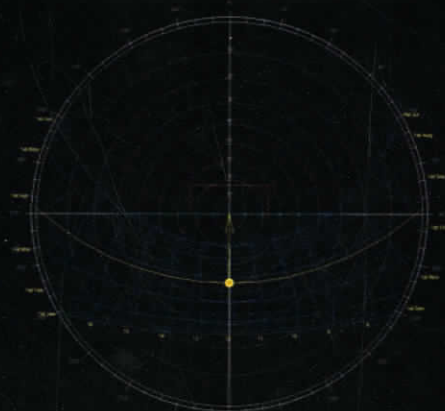


March 21 0600 Am



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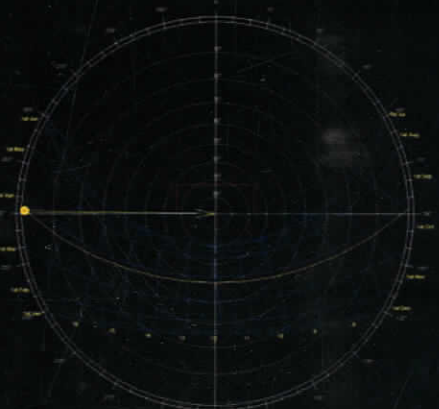
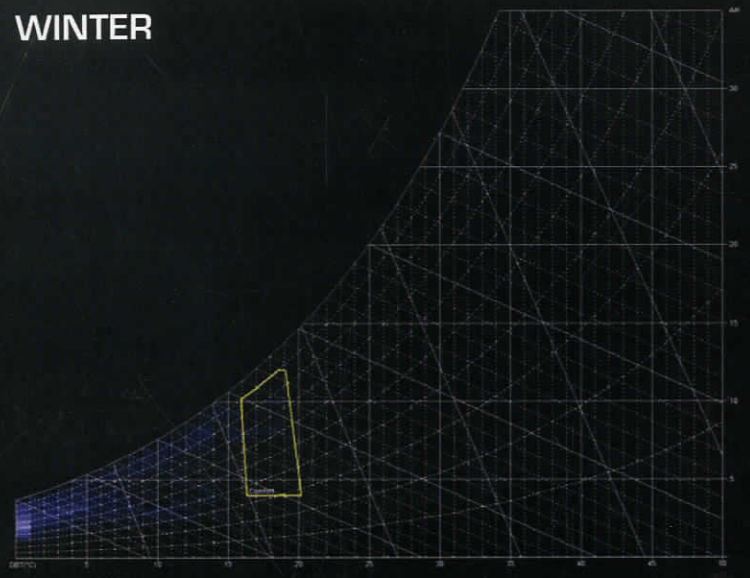


March 21 1800 pm

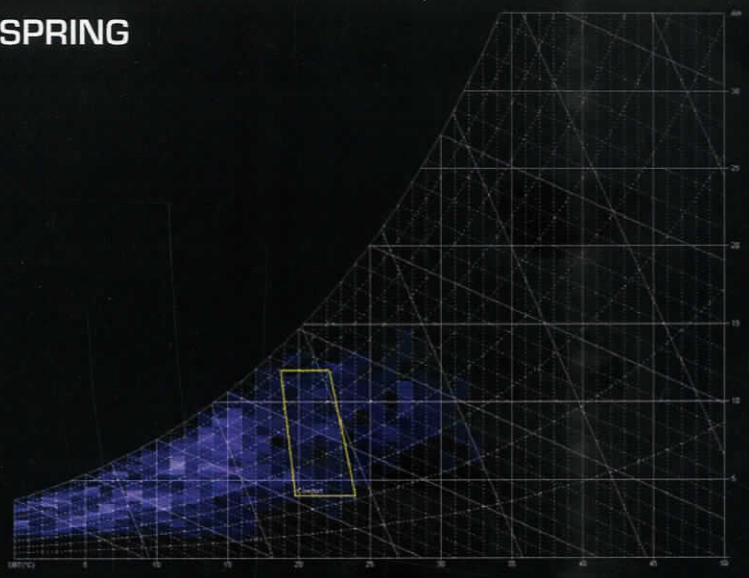
Climate Studies of Stamford, Ct

Psychrometric Chart for Stamford Ct.

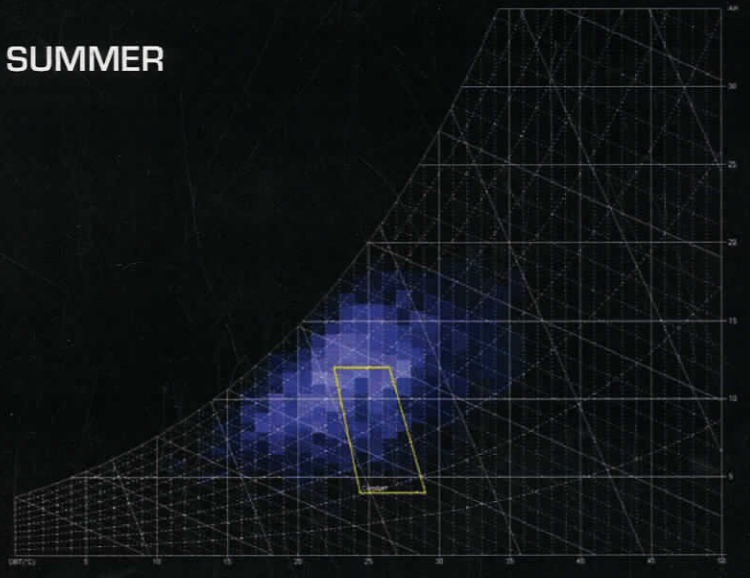
WINTER



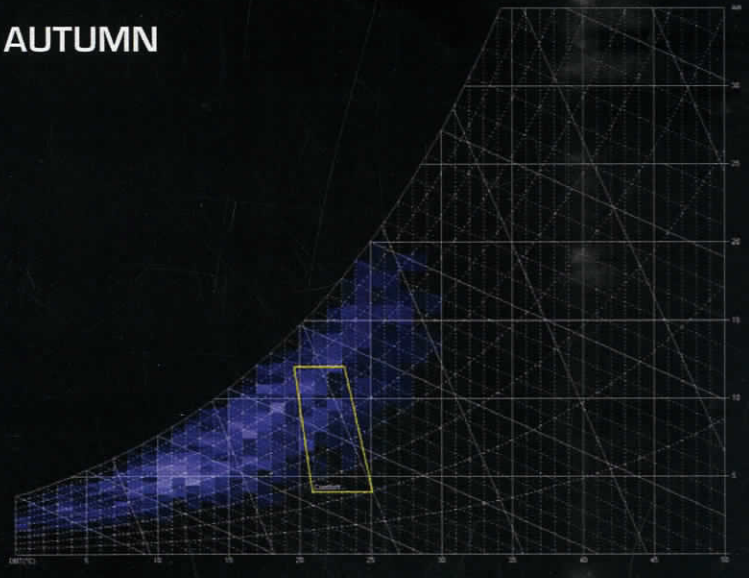
SPRING



SUMMER



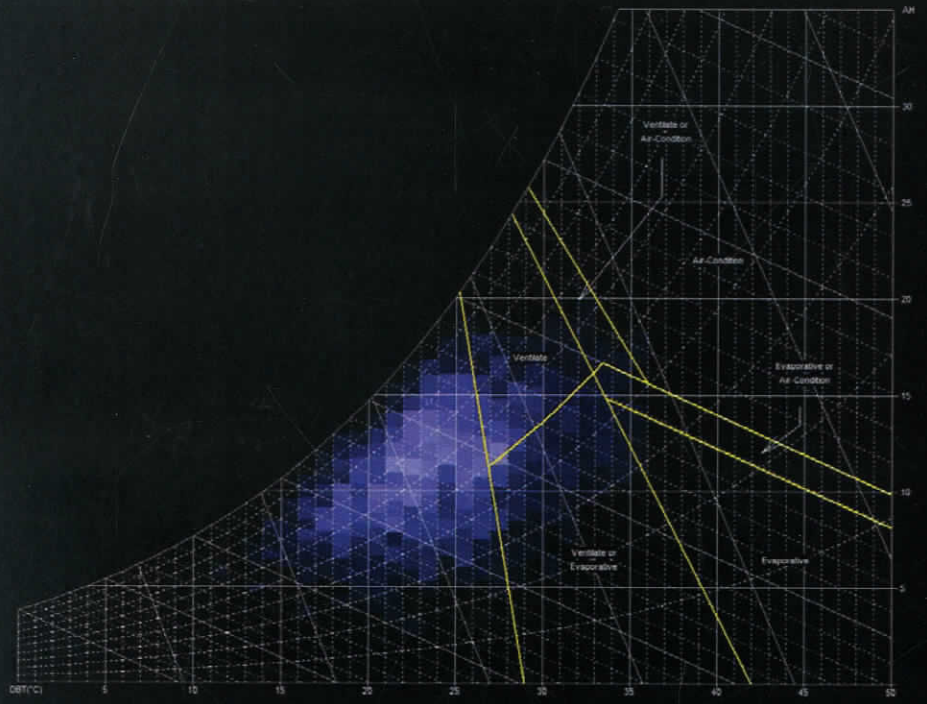
AUTUMN

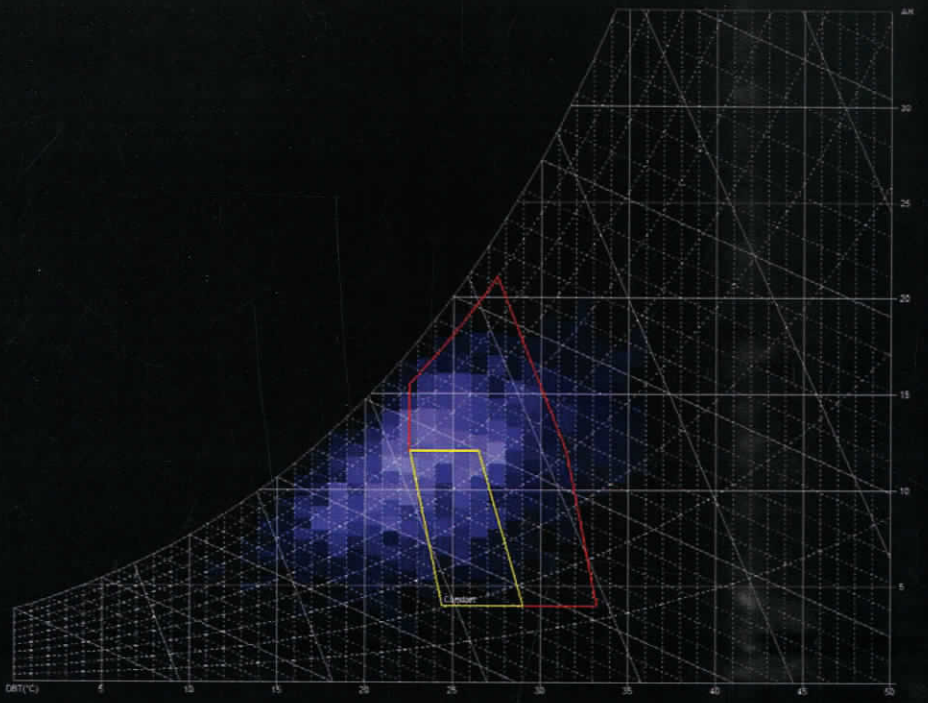


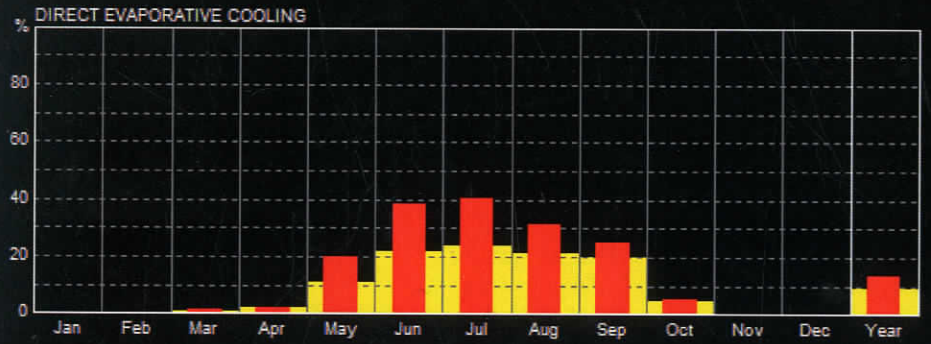
PART 4 DOCUMENTATION AND ANALYSIS OF SITE

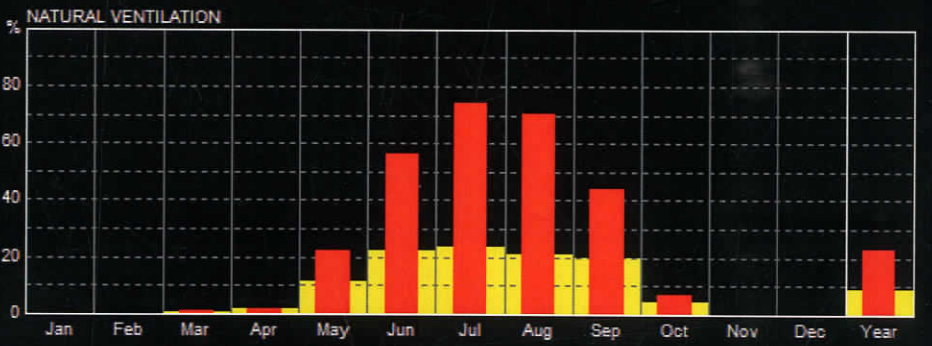
Climate Studies of Stamford, Ct

Summer Methods





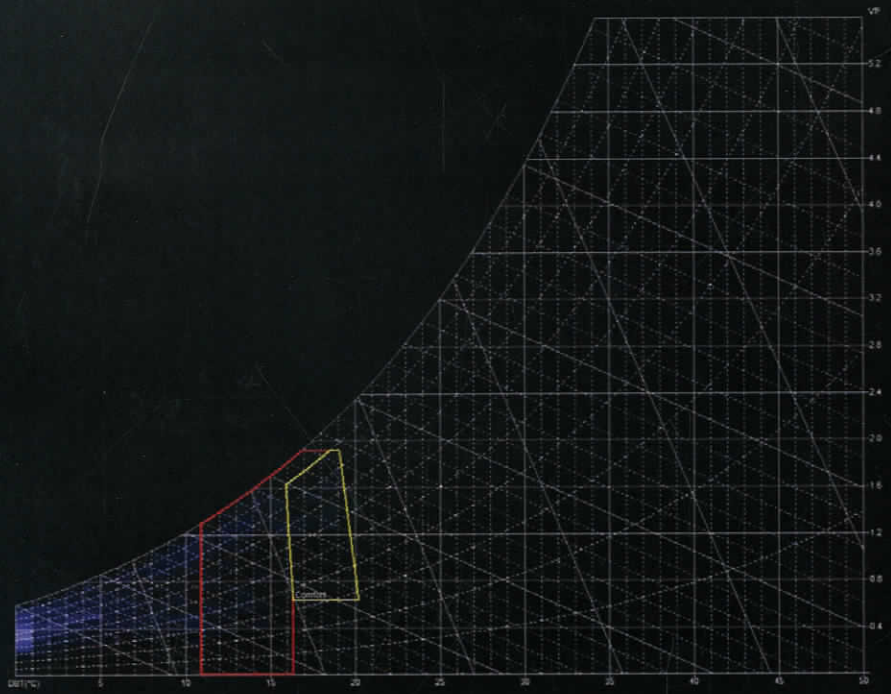


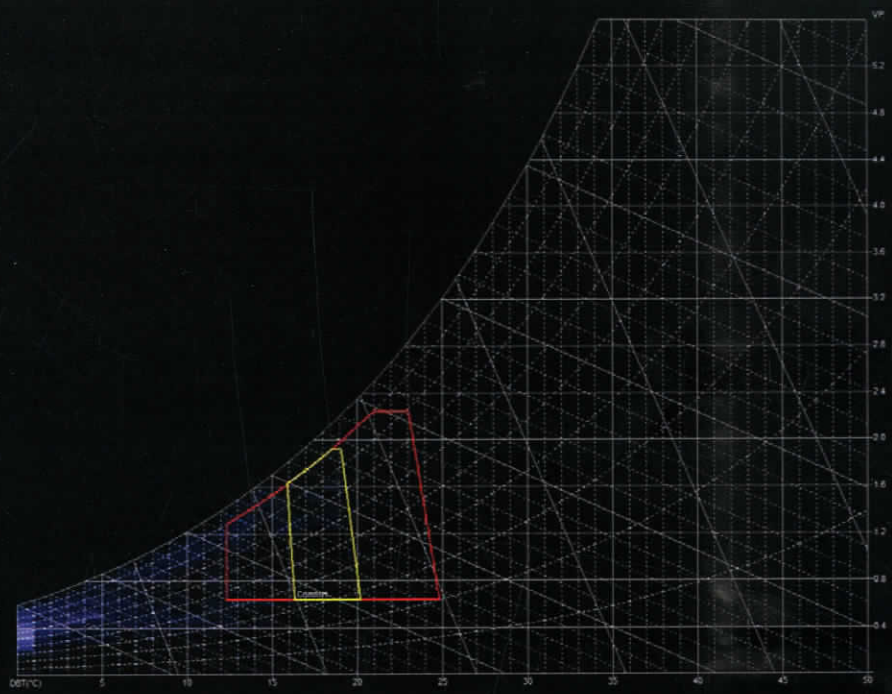


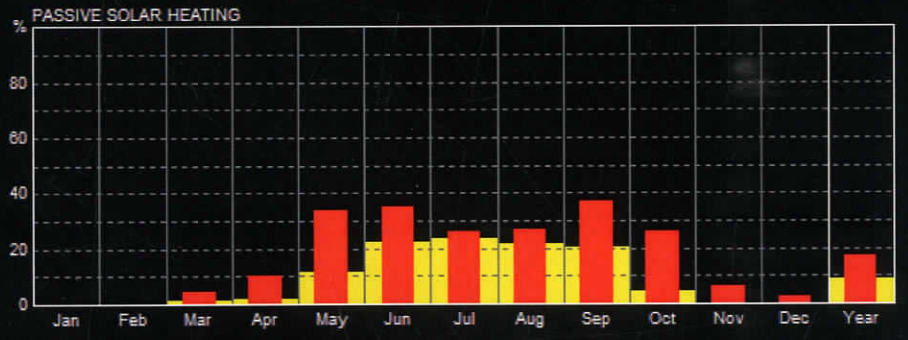
PART 4 DOCUMENTATION AND ANALYSIS OF SITE

Climate Studies of Stamford, Ct

Winter Methods



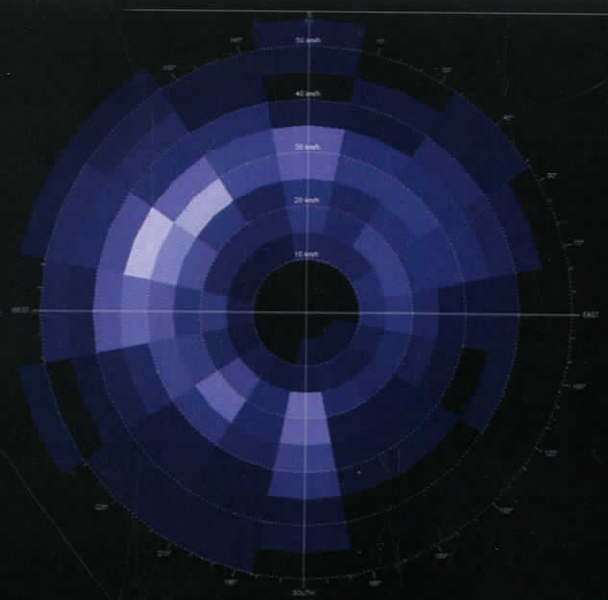




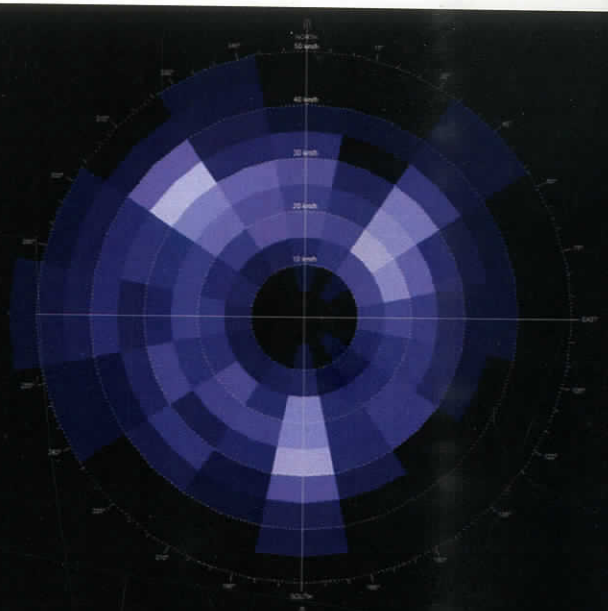
Climate Studies of Stamford, Ct

Wind Rose

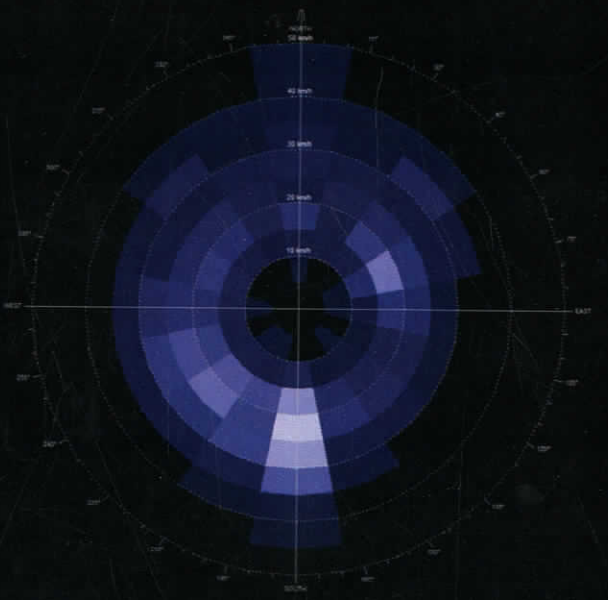
Winter (All Day)



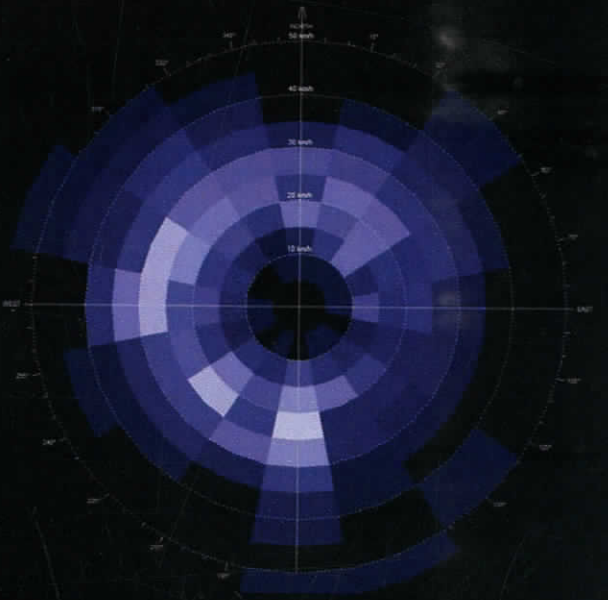
Spring (All Day)



Summer (All Day)



Autumn (All Day)



PART 4 DOCUMENTATION AND ANALYSIS OF SITE

Climate Studies of Stamford, Ct

Wind Rose

ALL YEAR/ ALL DAY
WIND FREQUENCY

SUMMER/ ALL DAY
WIND FREQUENCY

AUTUMN/ ALL DAY
WIND FREQUENCY

WINTER/ ALL DAY
WIND FREQUENCY

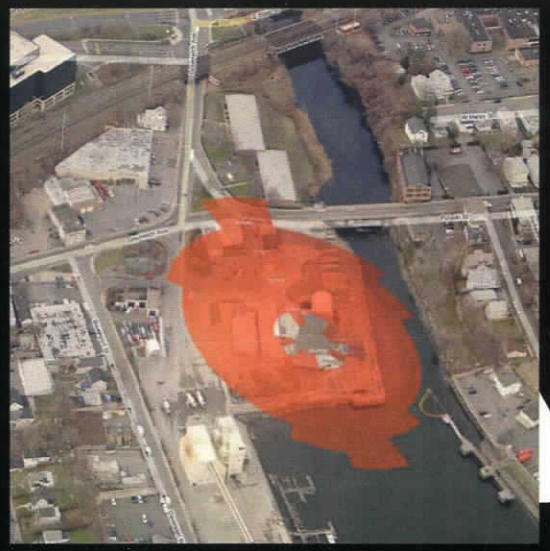
SPRING/ ALL DAY
WIND FREQUENCY

PART 4 DOCUMENTATION AND ANALYSIS OF SITE

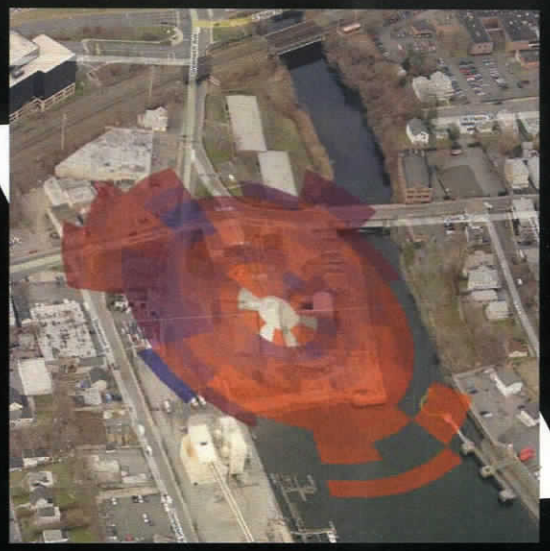
Climate Studies of Stamford, Ct

Wind Rose

ALL YEAR/ ALL DAY
AVERAGE WIND TEMPERATURES



SUMMER/ ALL DAY
AVERAGE WIND TEMPERATURES



AUTUMN/ ALL DAY
AVERAGE WIND TEMPERATURES

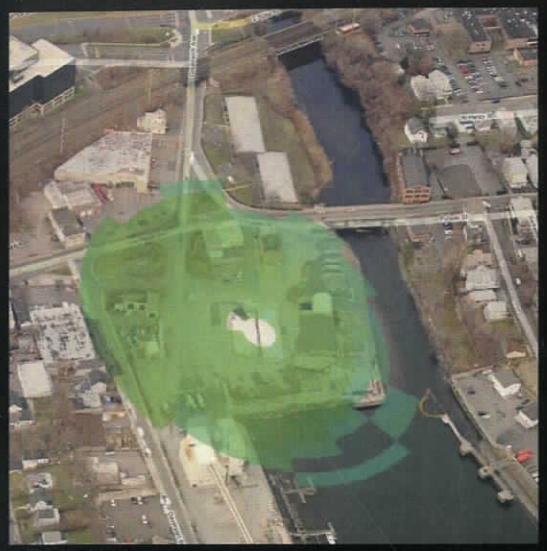
WINTER/ ALL DAY
AVERAGE WIND TEMPERATURES

SPRING/ ALL DAY
AVERAGE WIND TEMPERATURES

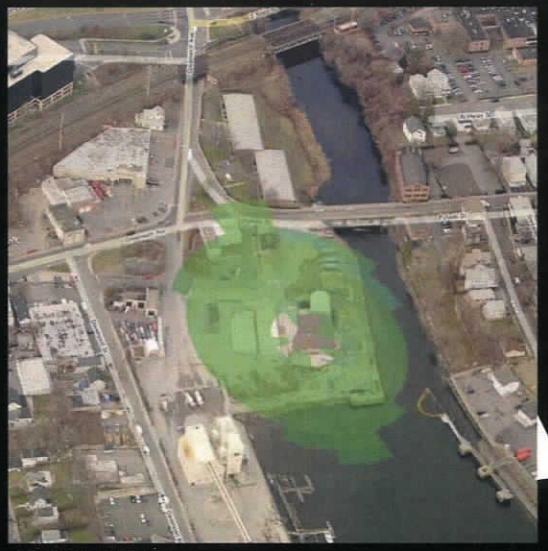
PART 4 DOCUMENTATION AND ANALYSIS OF SITE

Climate Studies of Stamford, Ct

Wind Rose

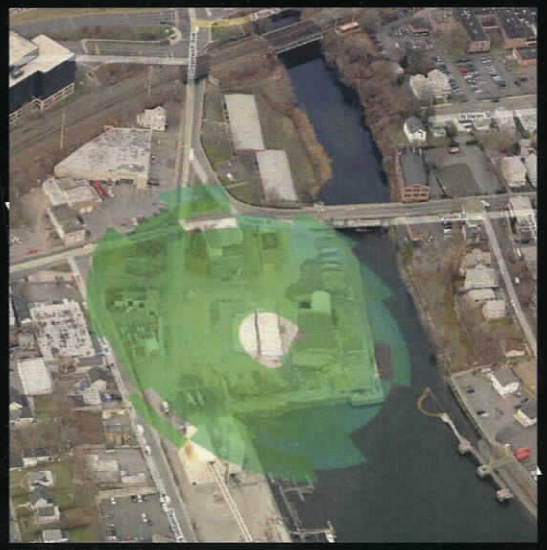


ALL YEAR/ ALL DAY
AVERAGE RELATIVE HUMIDITY

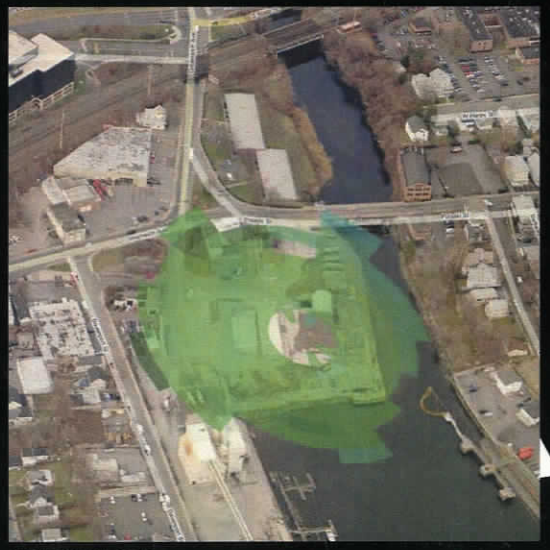


UMMER/ ALL DAY
AVERAGE RELATIVE HUMIDITY

AUTUMN/ ALL DAY
AVERAGE RELATIVE HUMIDITY



WINTER/ ALL DAY
AVERAGE RELATIVE HUMIDITY

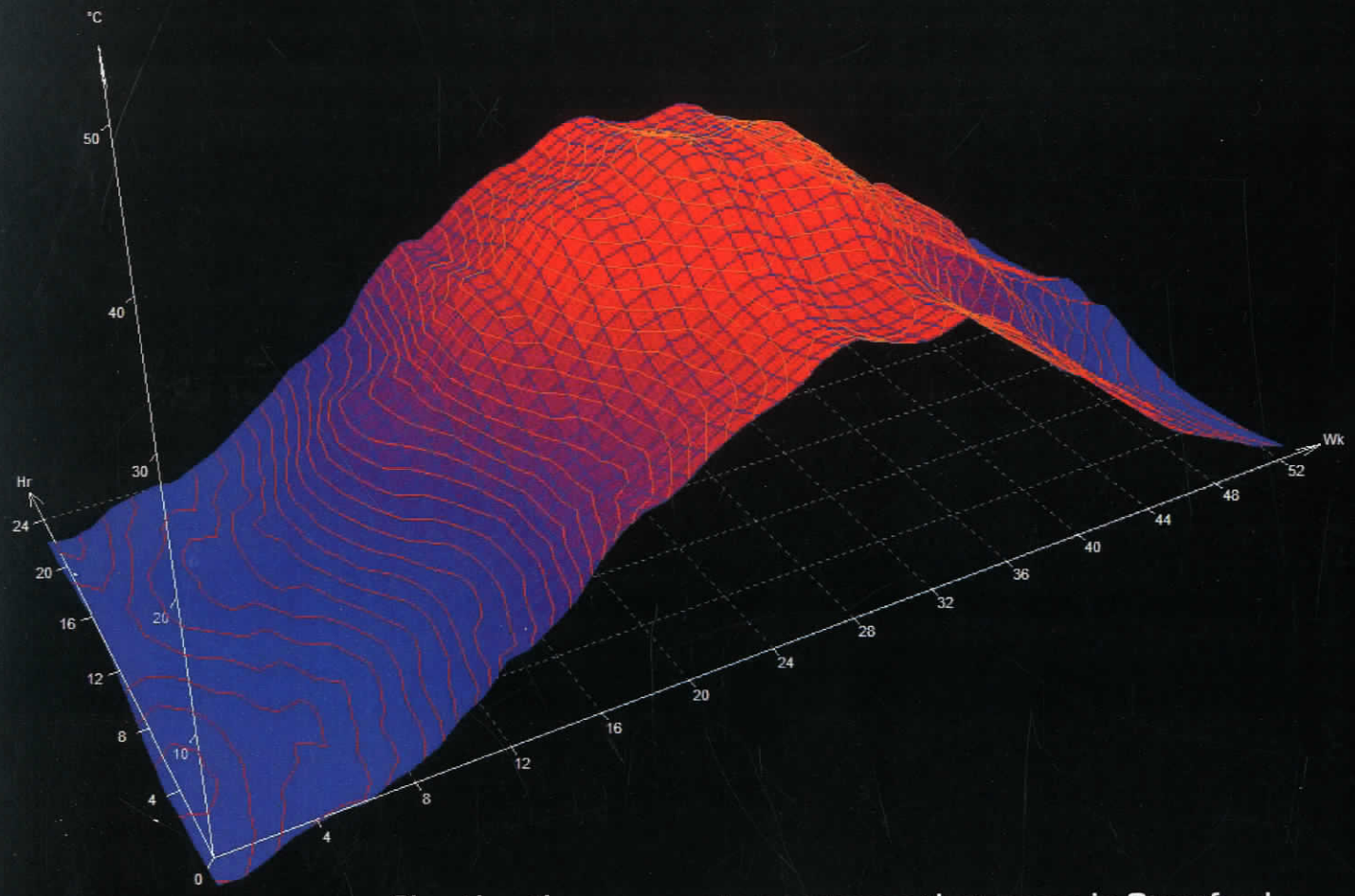


SPRING/ ALL DAY
AVERAGE RELATIVE HUMIDITY

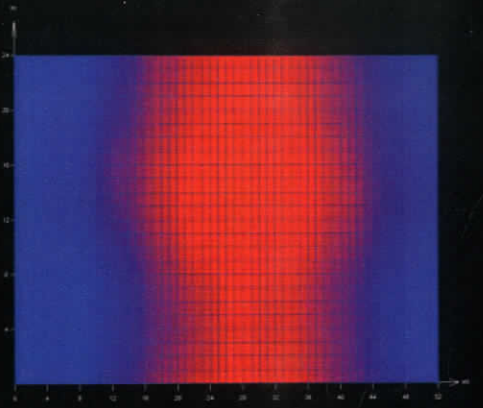
PART 4 DOCUMENTATION AND ANALYSIS OF SITE

Climate Studies of Stamford, Ct

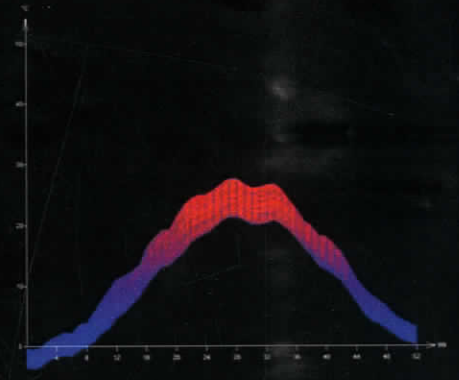
Average Temperature



Charting the average tempertures that occur in Stamford Ct. over the course of a year. Each x interval represents a 4 week span. Each y interval represents a 4 hours span.. And each z interval represents 10 degrees in celcius.



Plan Diagram for Average Temperature

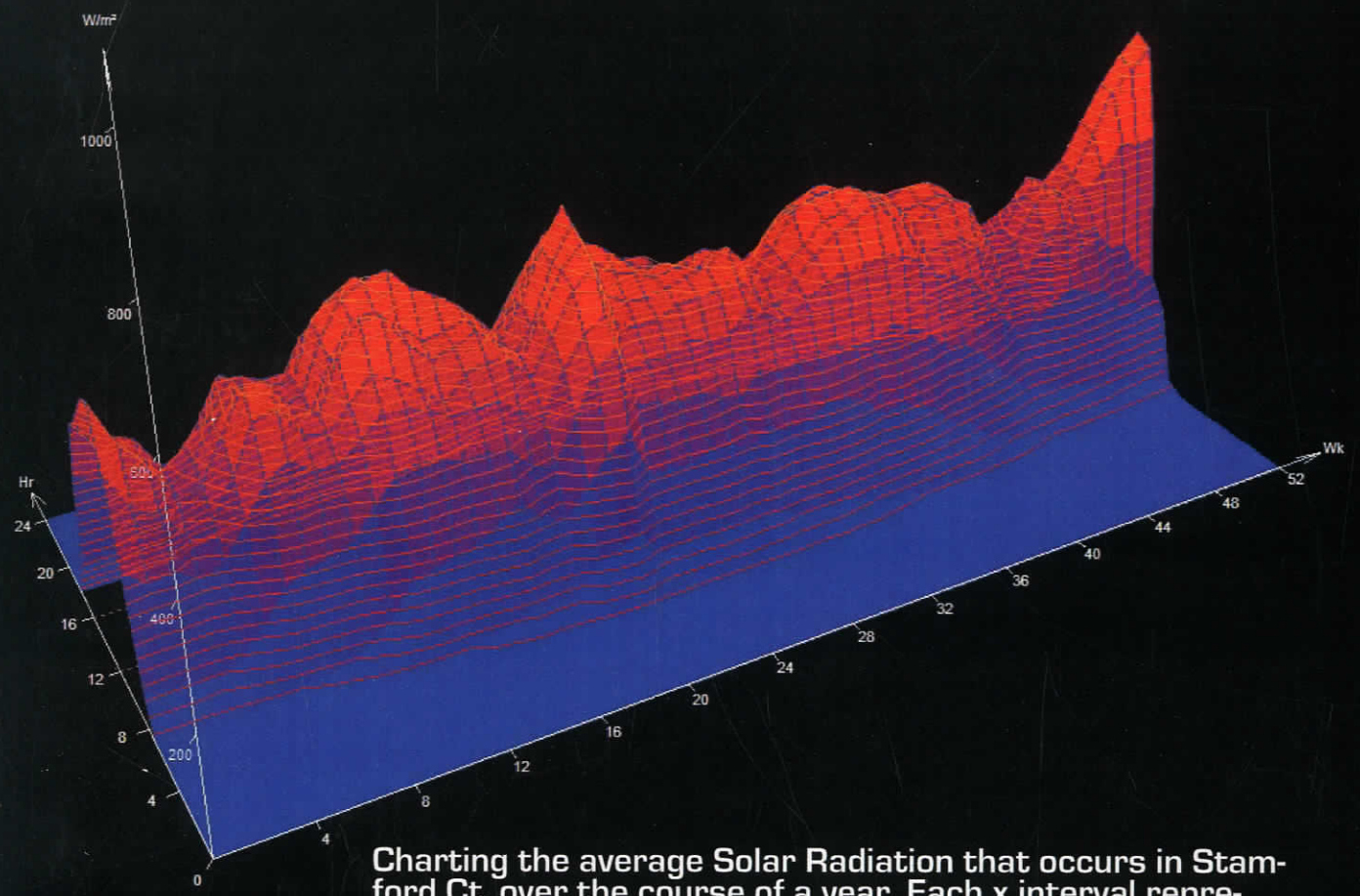


Sectional Diagram for Average Temperature

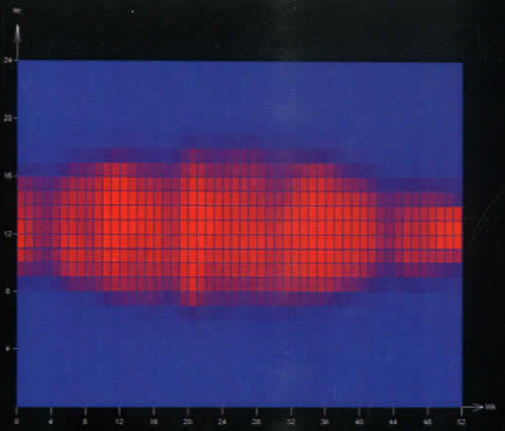
PART 4 DOCUMENTATION AND ANALYSIS OF SITE

Climate Studies of Stamford, Ct

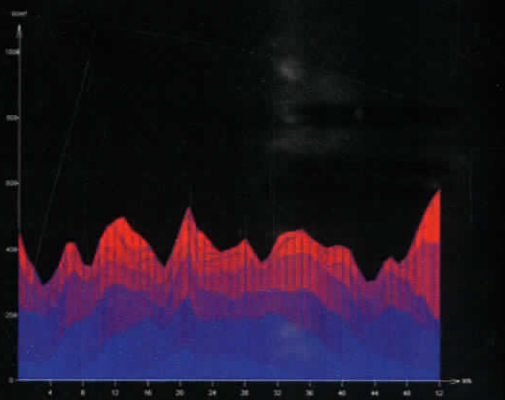
Average Solar Radiation



Charting the average Solar Radiation that occurs in Stamford Ct. over the course of a year. Each x interval represents a 4 week span. Each y interval represents a 4 hours span. And each z interval represents 100 w/m sq.



Plan Diagram for Average Solar Radiation

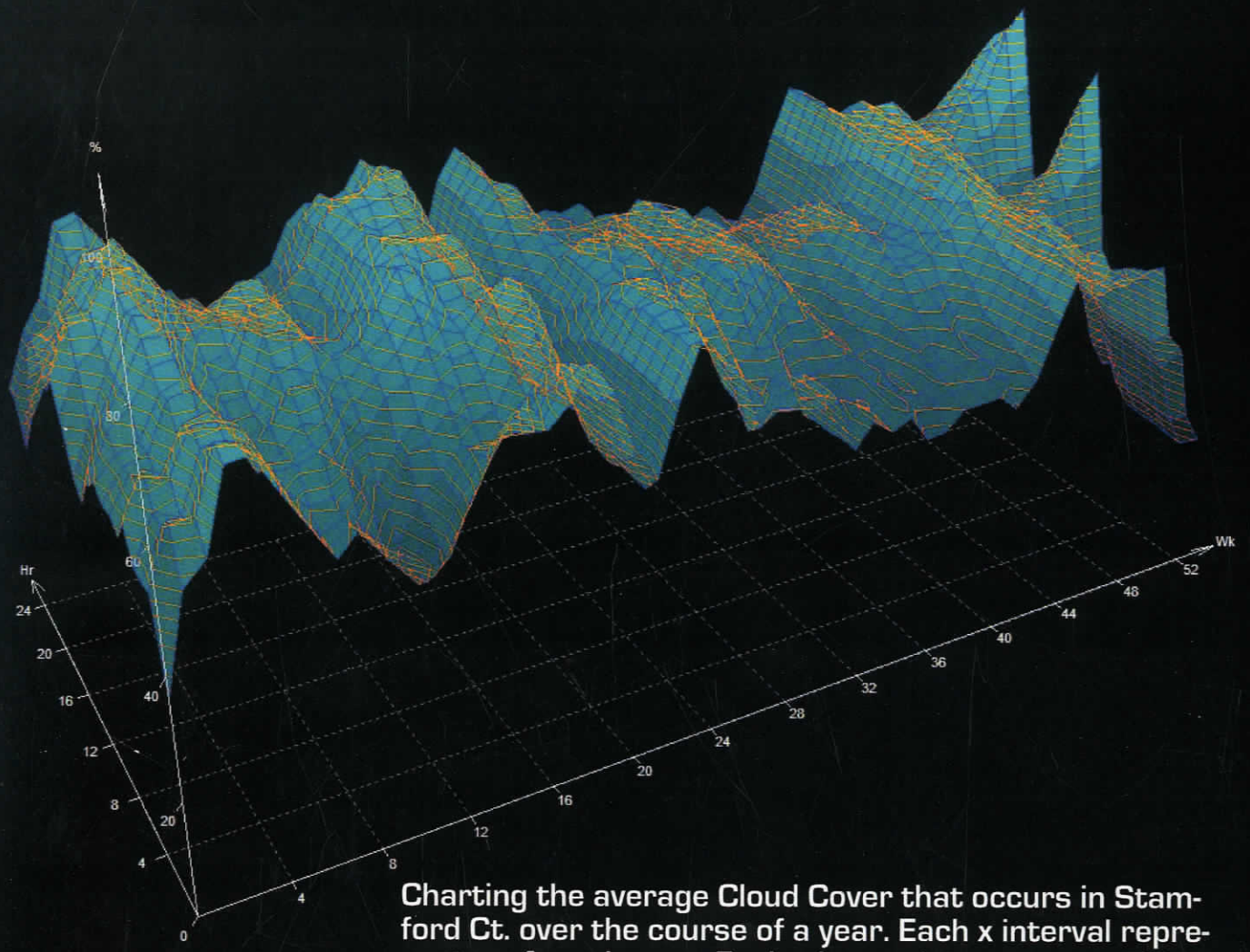


Sectional Diagram for Average Solar Radiation

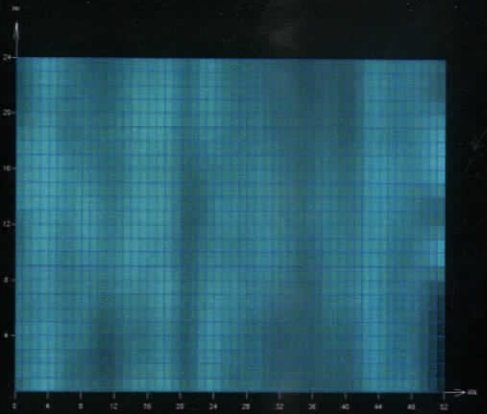
PART 4 DOCUMENTATION AND ANALYSIS OF SITE

Climate Studies of Stamford, Ct

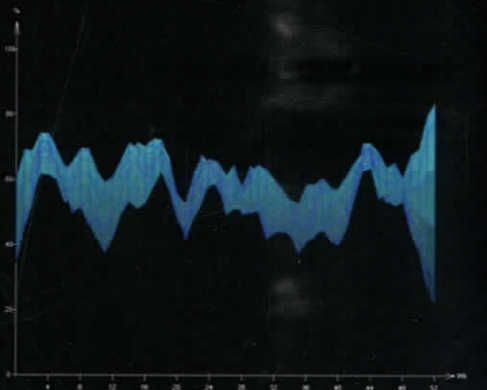
Average Cloud Cover



Charting the average Cloud Cover that occurs in Stamford Ct. over the course of a year. Each x interval represents a 4 week span. Each y interval represents a 4 hours span. And each z interval represents 20% coverage.



Plan Diagram for Average Cloud Cover

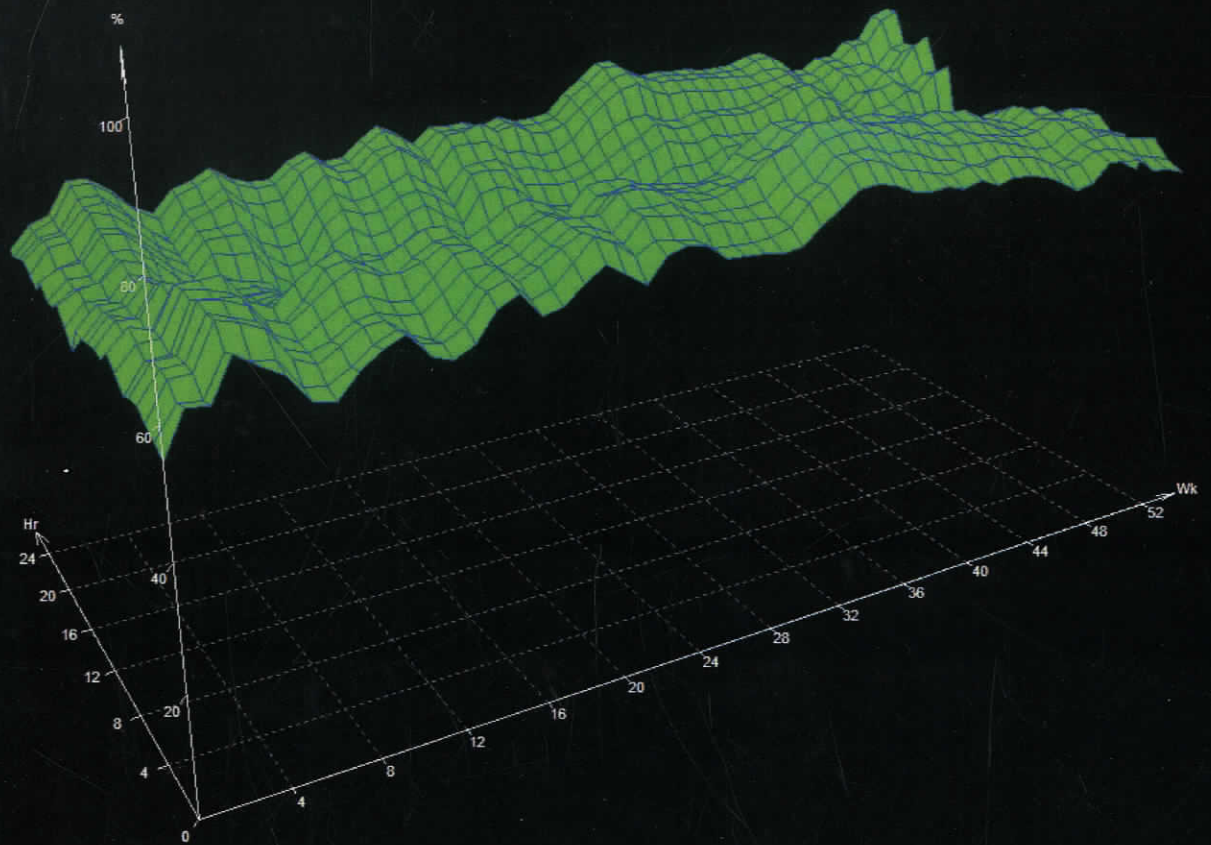


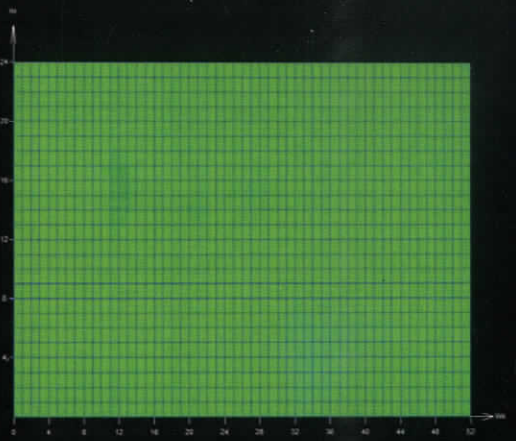
Sectional Diagram for Average Cloud Cover

PART 4 DOCUMENTATION AND ANALYSIS OF SITE

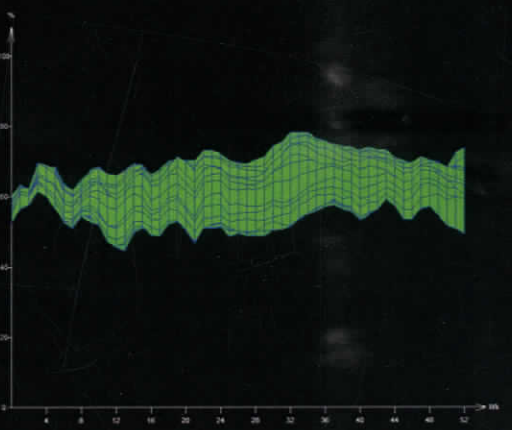
Climate Studies of Stamford, Ct

Relative Humidity





Plan of Relative Humidity



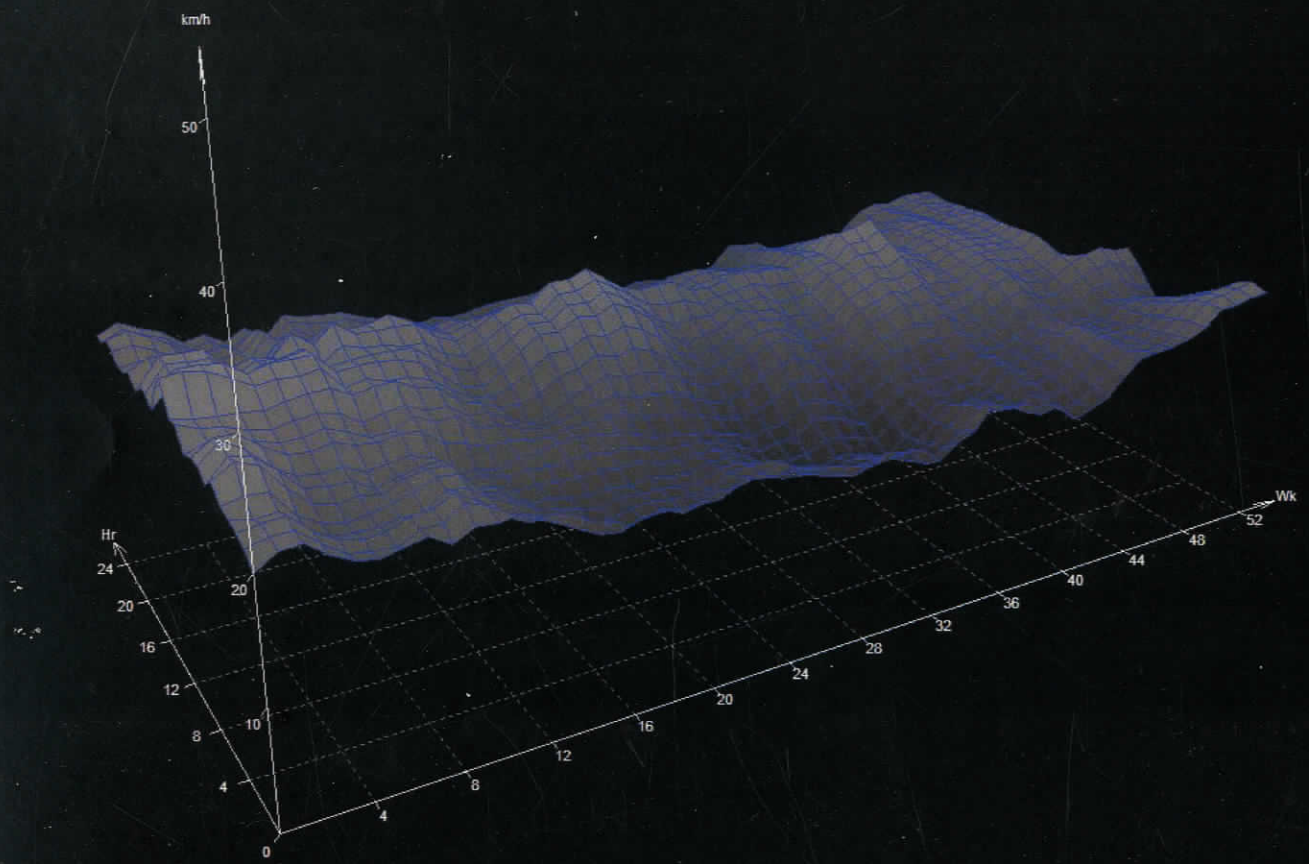
Sectional Diagram
for Relative Humidity

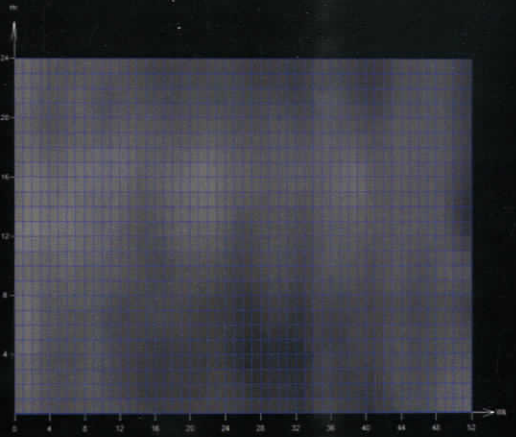
Charting the average Relative Humidity that occurs in Stamford Ct. over the course of a year. Each x interval represents a 4 week span. Each y interval represents a 4 hours span. And each z interval represents 20% Humidity.

PART 4 DOCUMENTATION AND ANALYSIS OF SITE

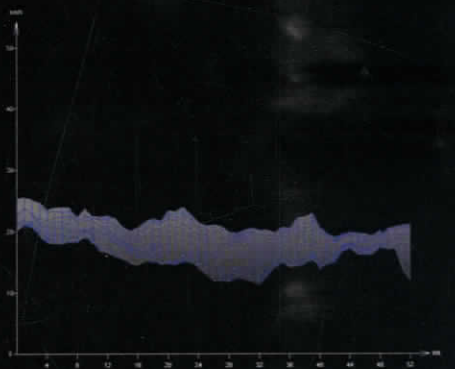
Climate Studies of Stamford, Ct

Average Wind Speed



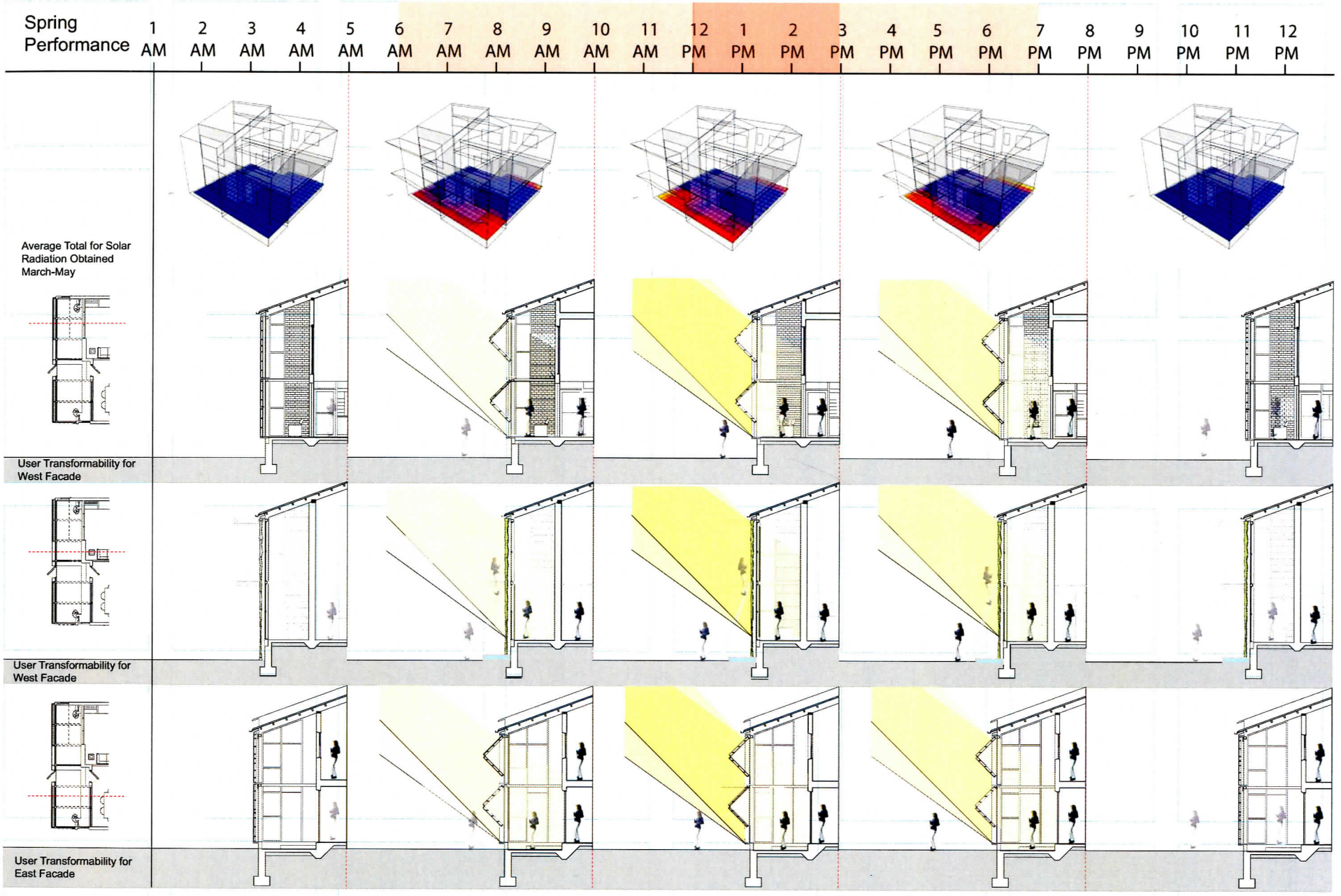


Sectional Diagram for Average Wind Speed

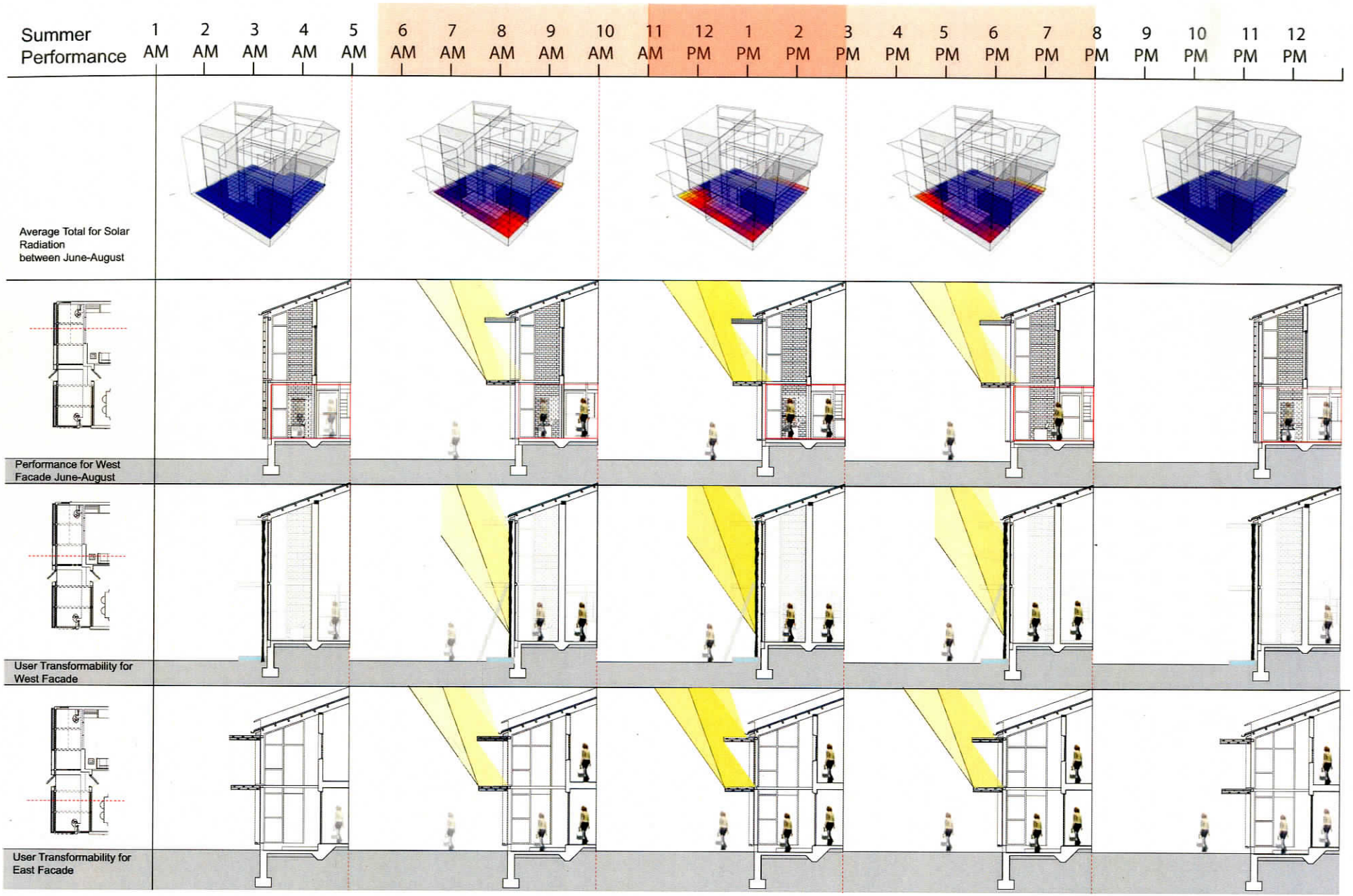


Sectional Diagram for Average Wind Speed

Charting the average Wind Speed that occurs in Stamford Ct. over the course of a year. Each x interval represents a 4 week span. Each y interval represents a 4 hours span. And each z interval represents 10 km/h.



PART 5 THESIS DOCUMENTATION



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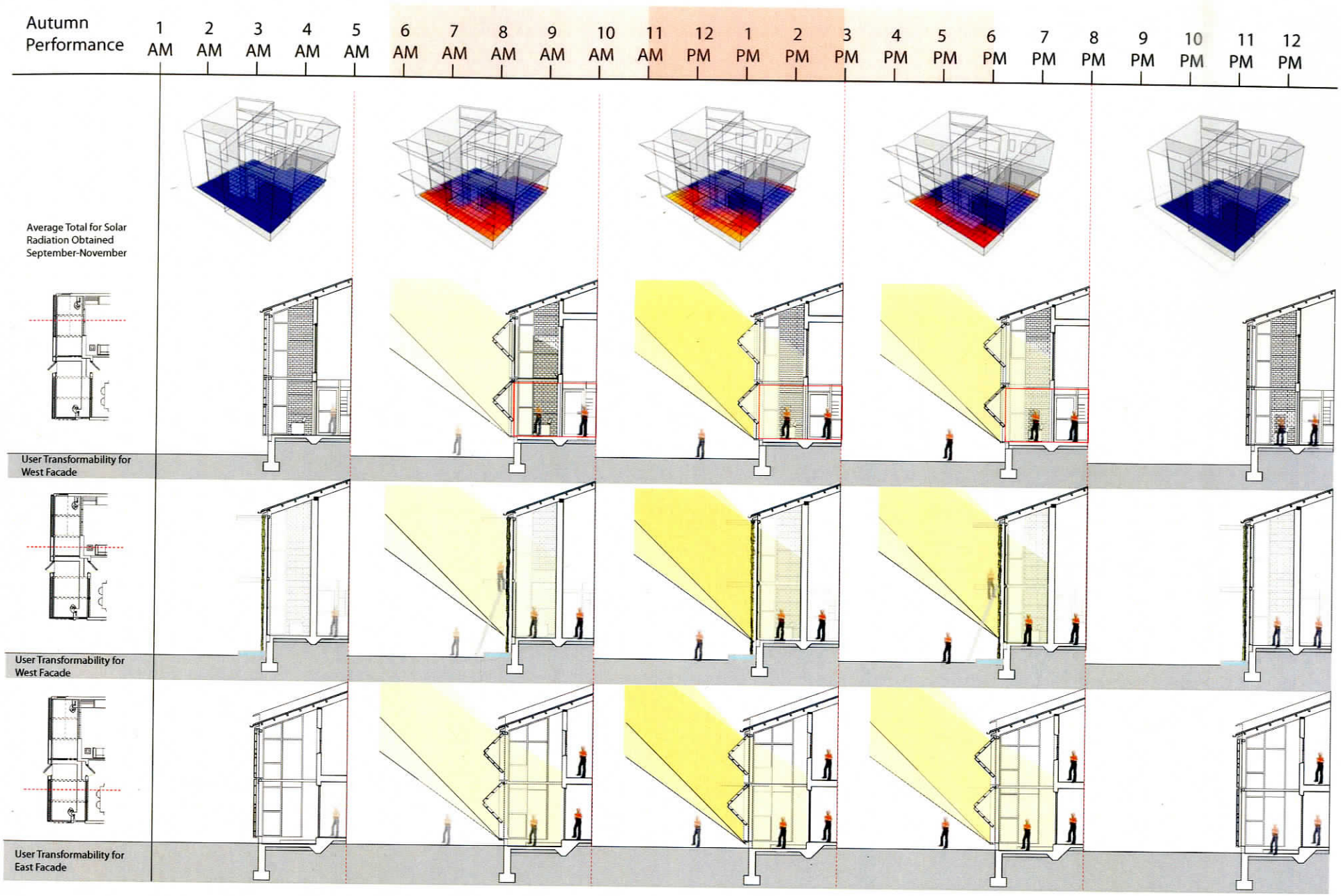

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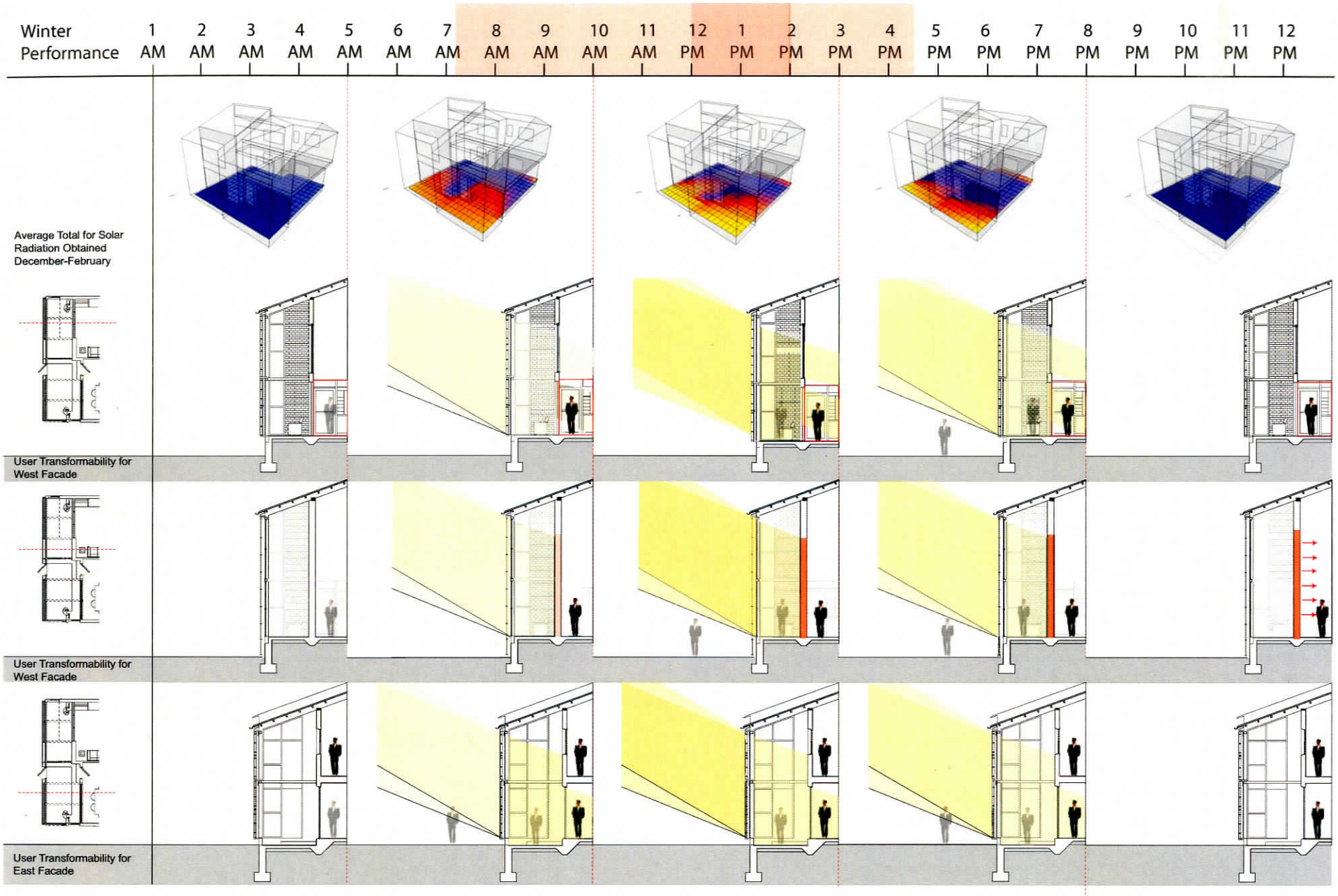

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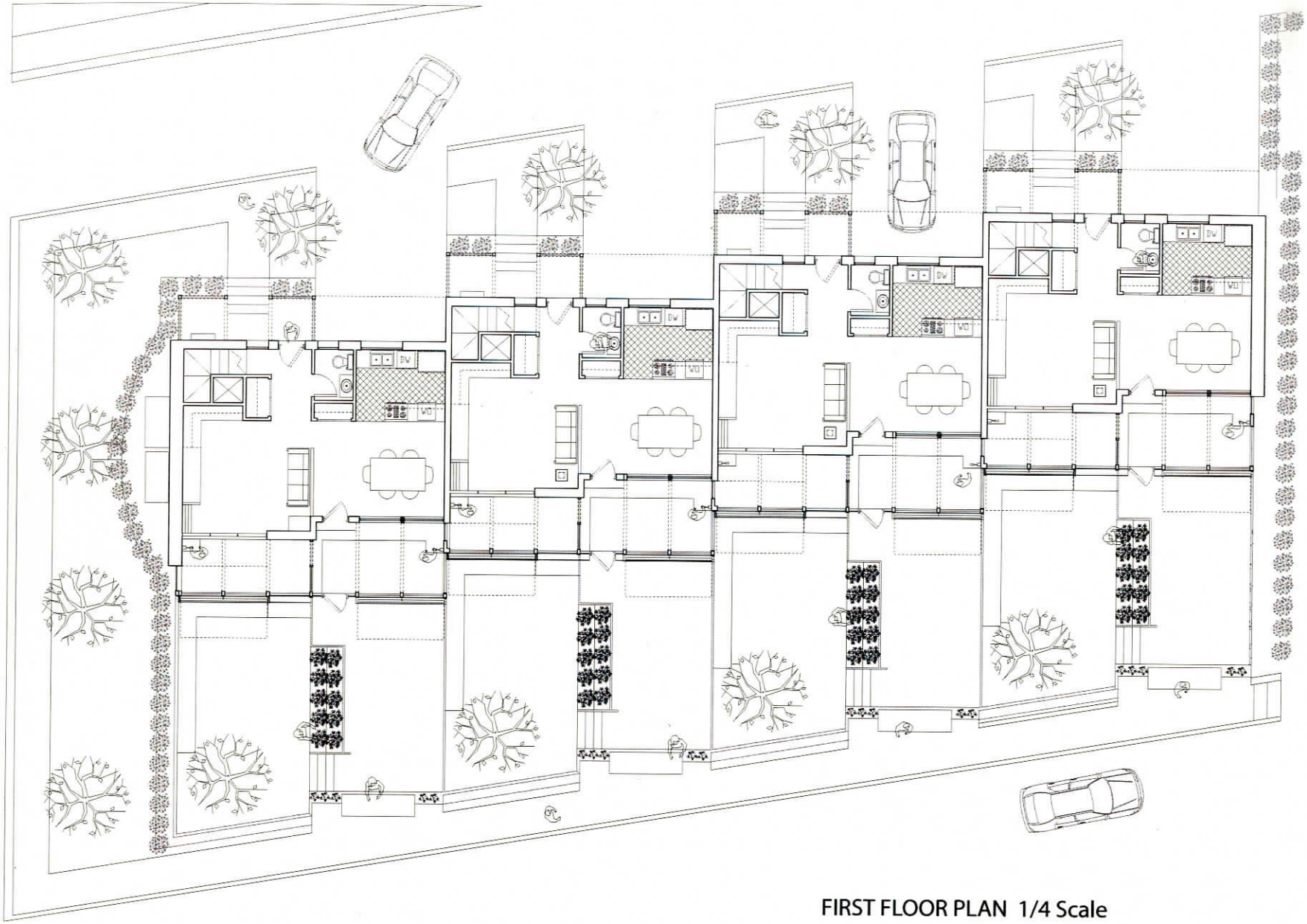
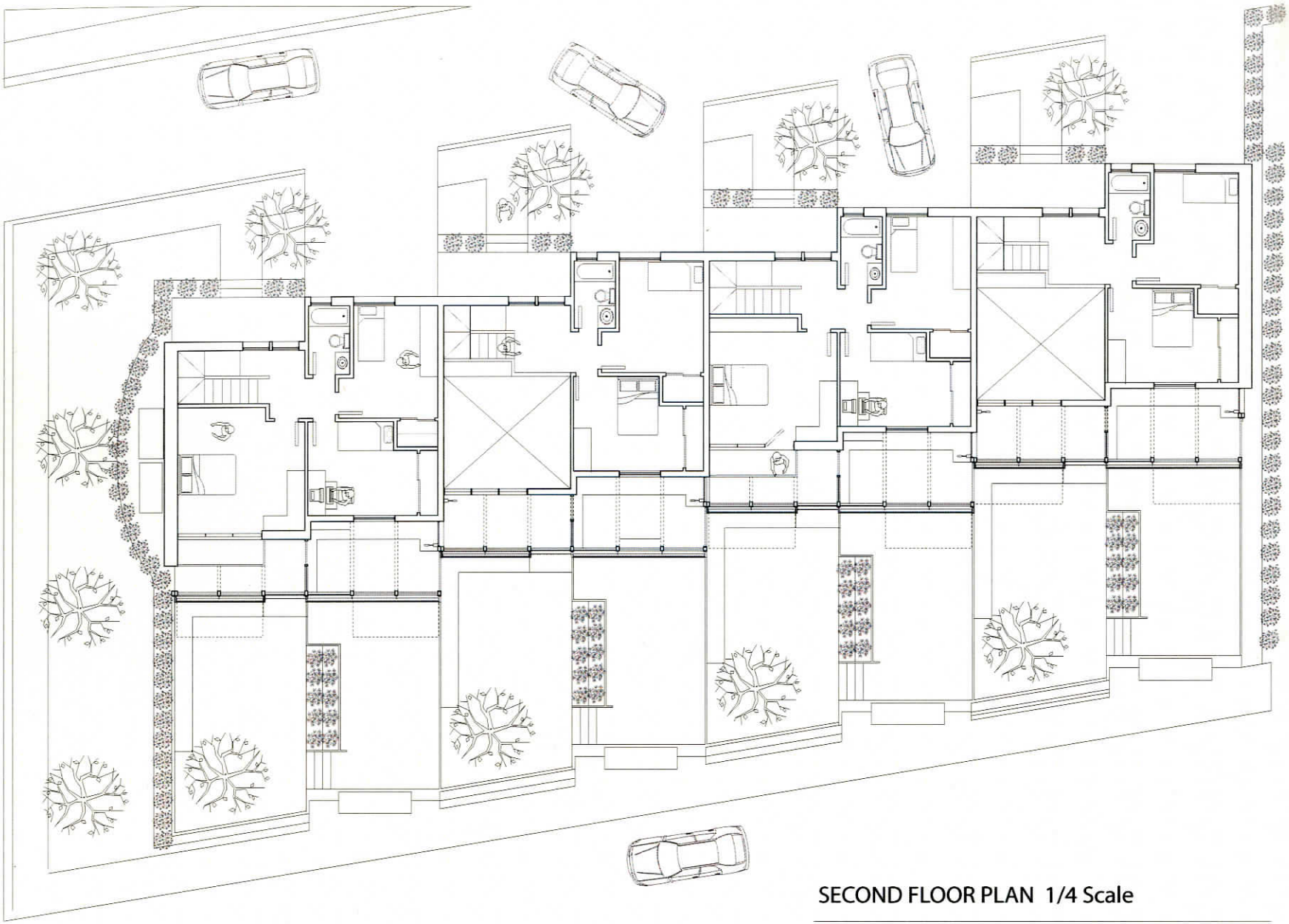


FIRST FLOOR PLAN 1/4 Scale

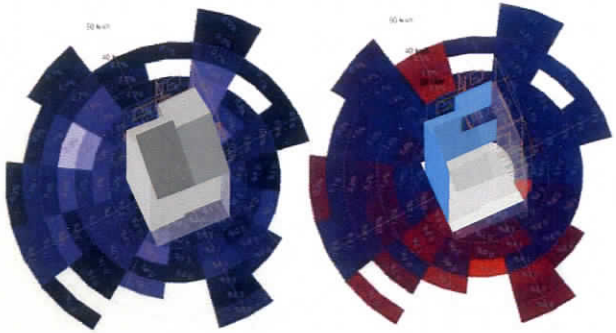
PART 5 THESIS DOCUMENTATION



SECOND FLOOR PLAN 1/4 Scale

SPRING

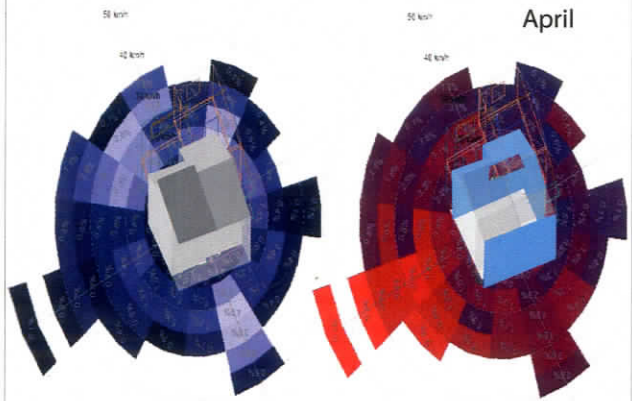
March



Frequency

Temperature

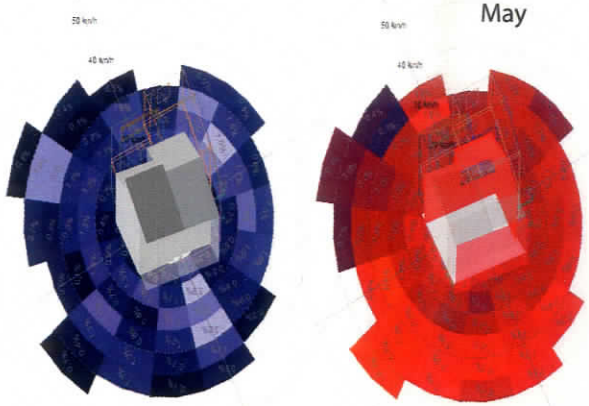
April



Frequency

Temperature

May

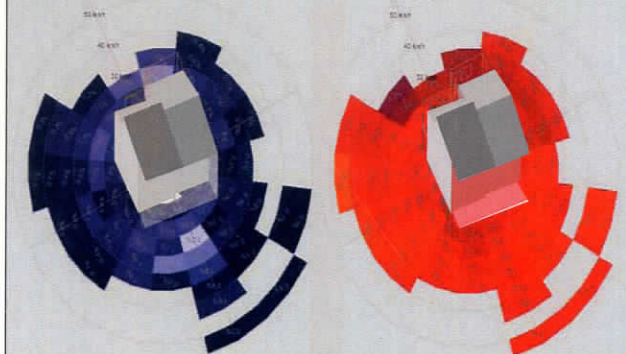


Frequency

Temperature

AUTUMN

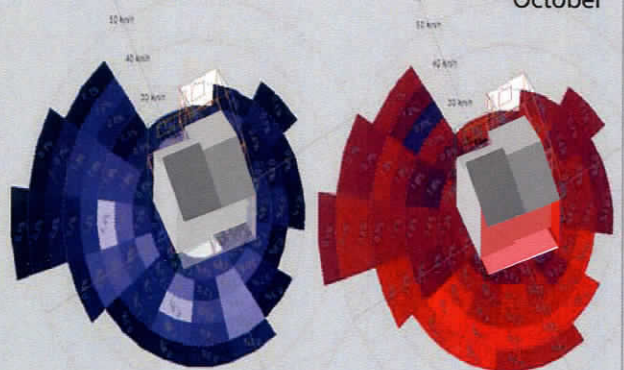
September



Frequency

Temperature

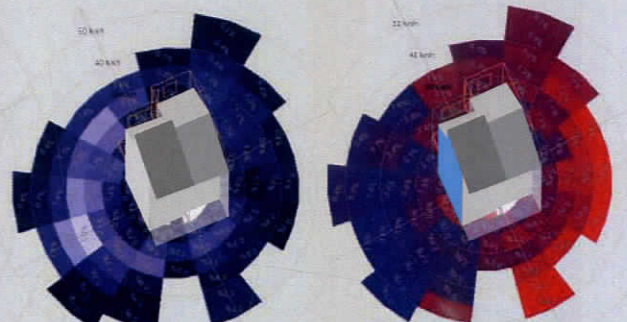
October



Frequency

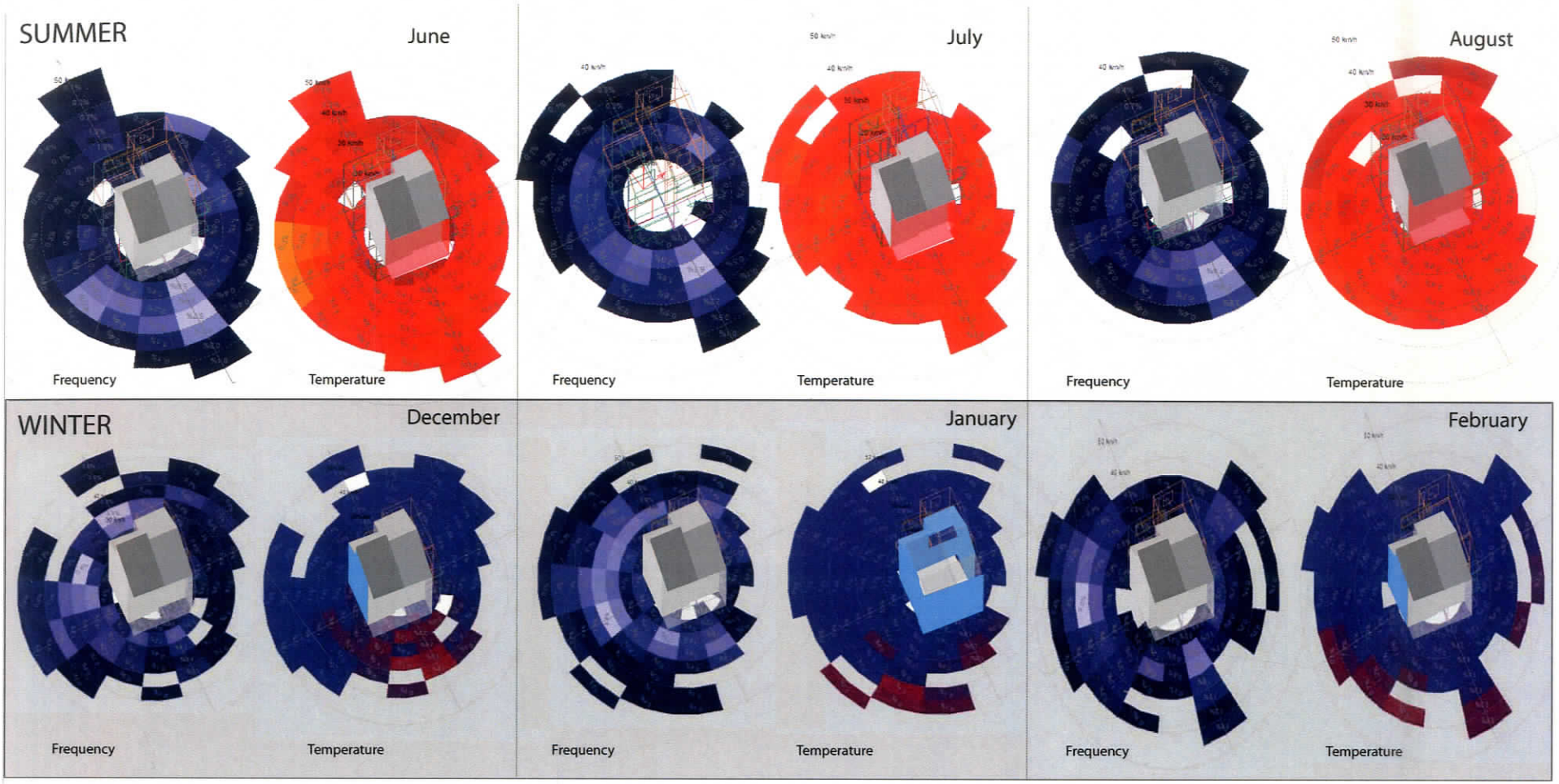
Temperature

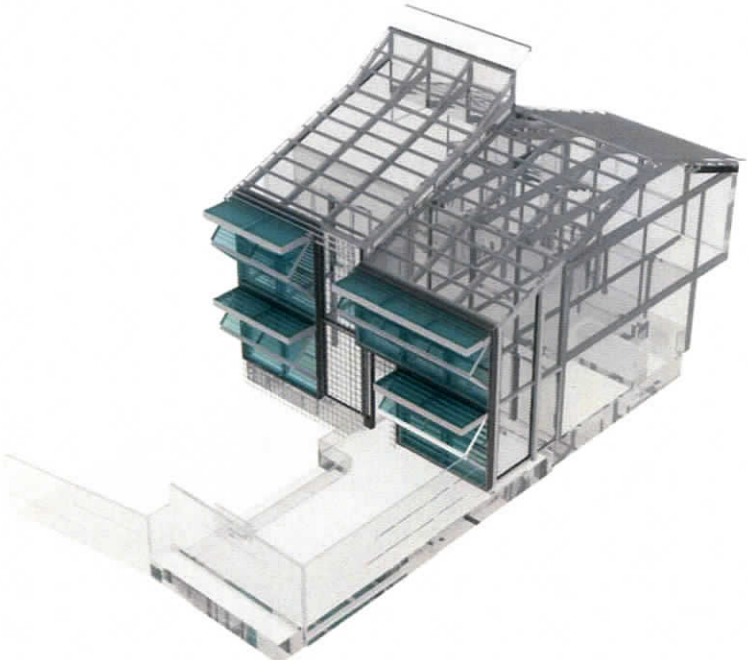
November

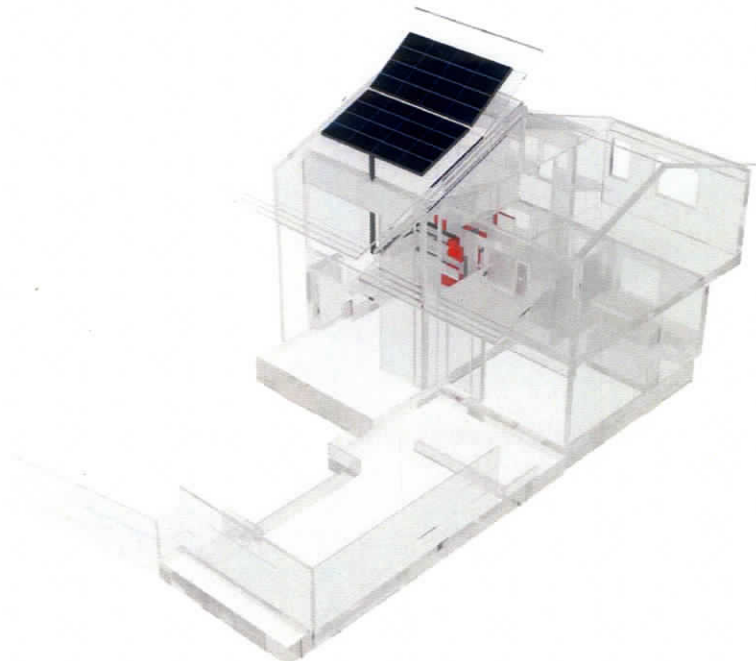


Frequency

Temperature

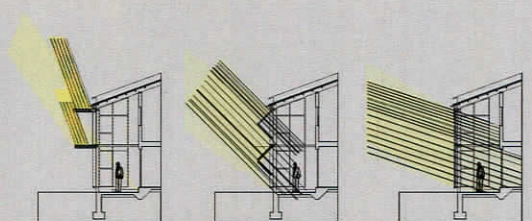

SUMMER
June
July
August
Frequency
Temperature
Frequency
Temperature
Frequency
Temperature
WINTER
December
January
February
Frequency
Temperature
Frequency
Temperature
Frequency
Temperature





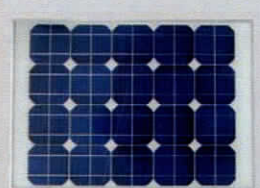
Aluminum bi-fold hanger doors on South Facade

Precedent:
Loblolly House, KieranTimberlake Associates LLP

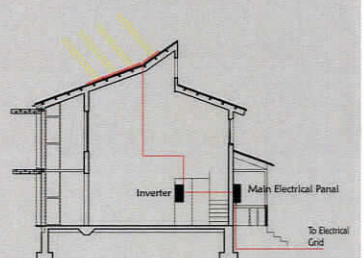


Aluminum hanger doors provide the user the ability to transform there own enclosure system and be able to be in control of how there unit performs. Each panal is equiped with a series of louvers that remain at the same angle no matter what the position of the doors. This allows for the maximum amout of light to pass throughz when the doors are down however blocking the light when the are placed at the top position.

Grid Connected Photo-Voltaic Solar Panals

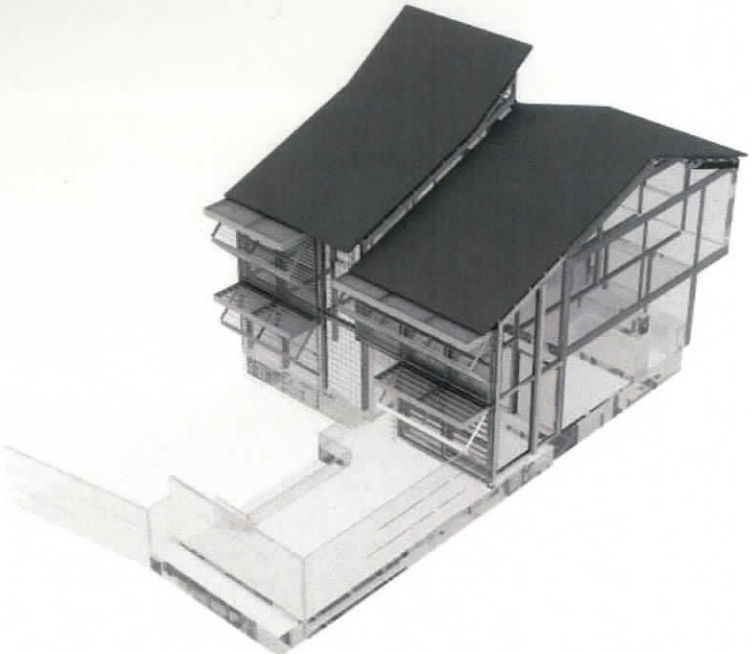


300 Sq/ft of PV Panals

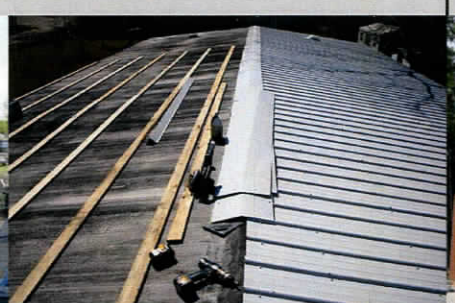


Grid-connected PV power offers consumers both economic and environmental advantages. Where utility power is available, consumers can use a grid-connected PV system to supply a portion of the power they need while using utility-generated power at night and on very cloudy days. When the PV system supplies power to the grid as well as to a specific building or piece of equipment, the utility becomes a storage device or battery for PV-generated power.

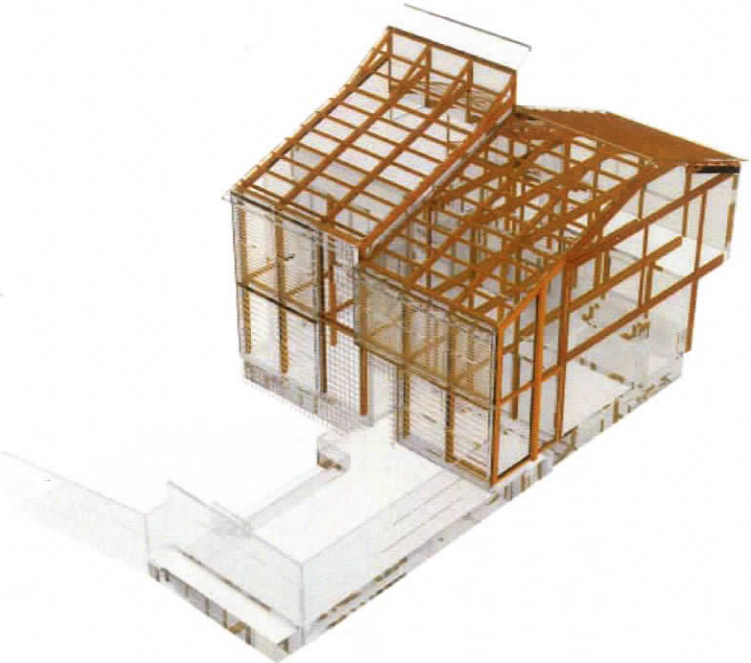
PART 5 THESIS DOCUMENTATION



Metal Roof

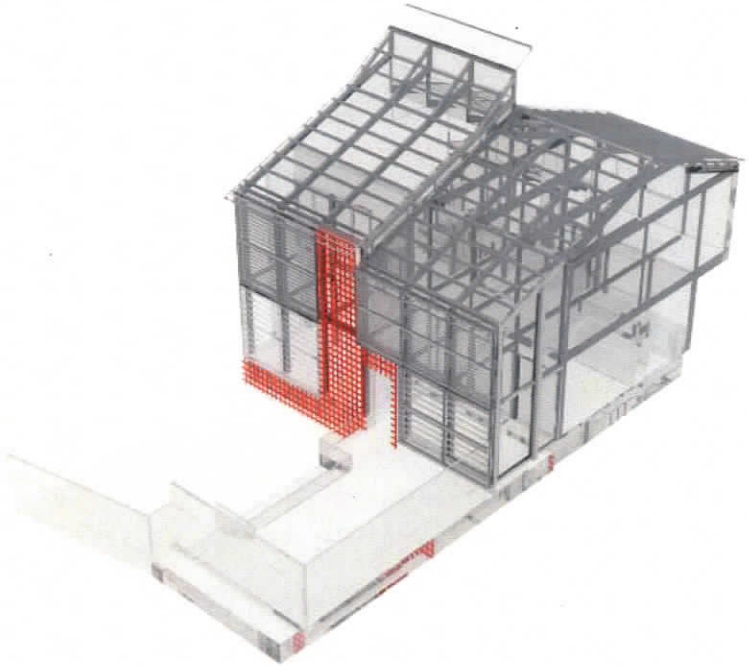


-Due to global warming , weather conditions have become more and more intense over the past decade.
-Metal roofing prevents the stress of yearly maintenance and instead brings a peace of mind by using a material that is extra durable extremely weatherproof, recyclable and reflect the hot rays of the sun during the summer.

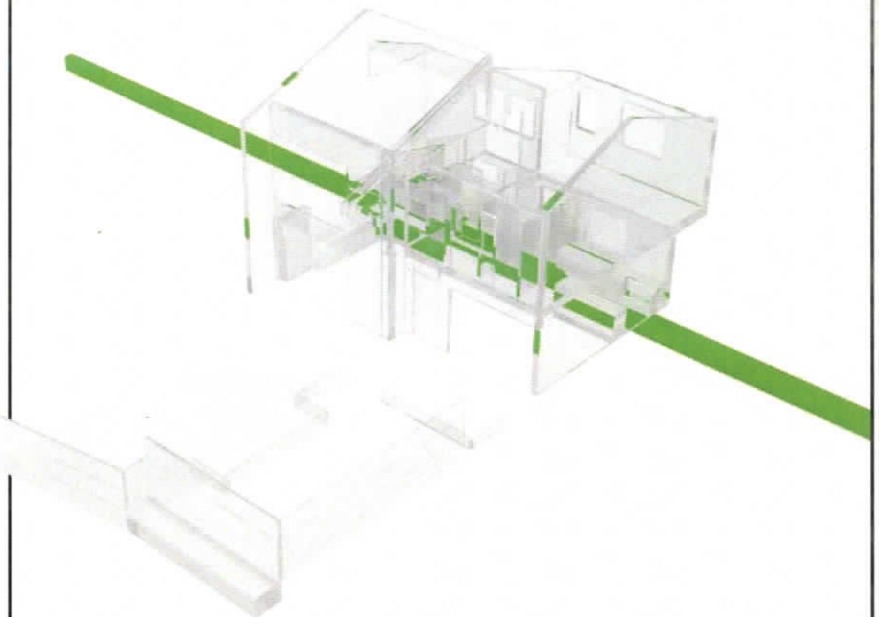


Timber Frame Construction

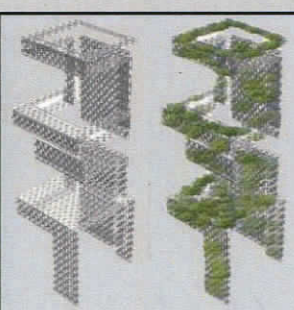
Timber framing has a natural advantage in sustainable construction. It is recyclable, biodegradable, and renewable. It requires low energy inputs to harvest, transport, and mill, and it is naturally absorbed back into the earth with no environmental harm since it is organic and non-toxic. The renewability of wood, makes it the most sustainable construction material available.



Hyrdroponic Wall

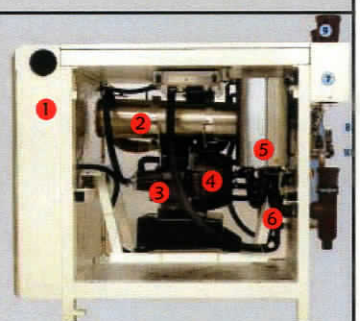


On Site Micro Congeneration Dispersal

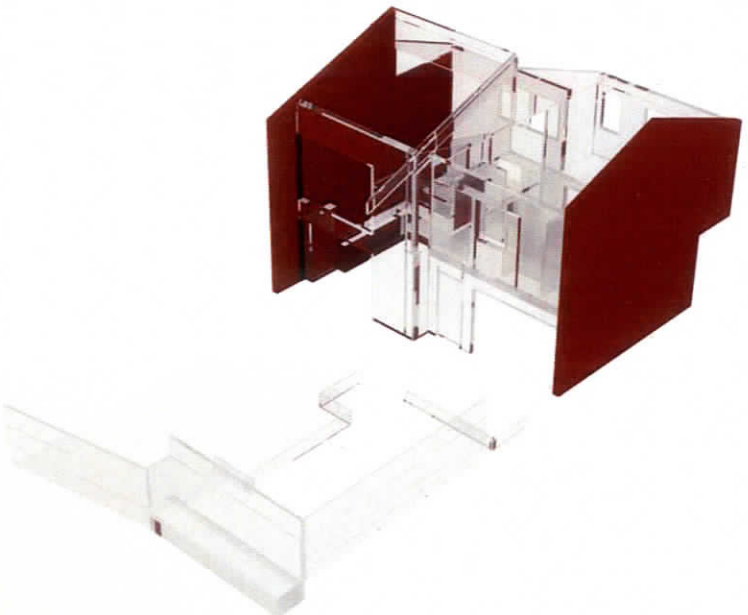


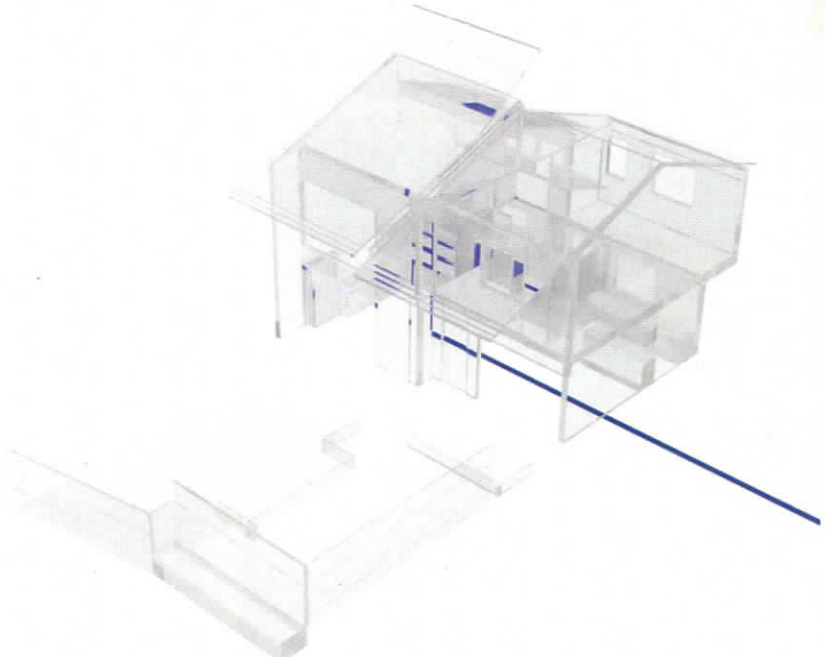
The hanging hydroponic wall allows for shading to housing unit during the hotsummer days diffusing the sunlight that trys to penetrate the skin of the building. During the Winter when the vegesation dies out the light from the sun is able to pass through in greater amounts allowing for the maximum amout of solar radiation to go into the house ro be absorbed.

Combined Heat and Power:
-Liquid cooled internal combustion engine generates heat which is pumped through a heat exchanger and subsequently used for domestic use.
-In addition a generator is driven by the engine and provides power for on-site electrical consumption by the user. Up to 92% of the electricity and heat is utilized.

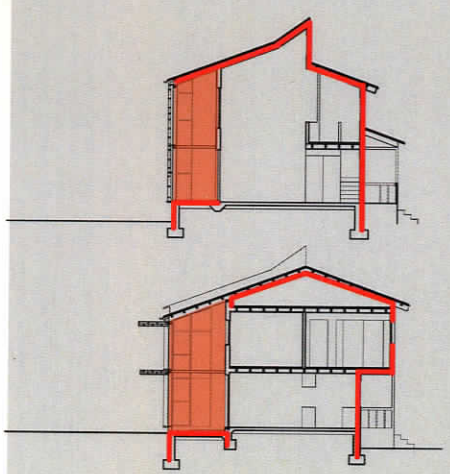


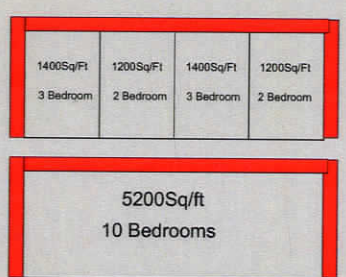
1. Control Box
2. Flue gas heat
3. Engine Unit
4. Generator
5. Silencer
6. Heat exchanger heating system
7. Electronic Connections
8. Gas Supply
9. Fresh air/flue gas
10. Heating Connections





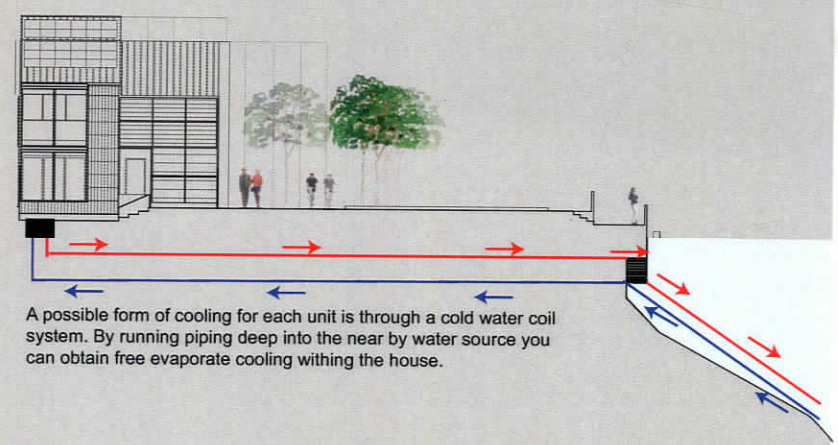
Insulation





-Each of the units stacked next to each other provides an layer of insulation on the houses east west axis.
-The semi climatized zone provides a thick layer of insulation for the south face of the house.

Cold Water Coil System



A possible form of cooling for each unit is through a cold water coil system. By running piping deep into the near by water source you can obtain free evaporate cooling withing the house.

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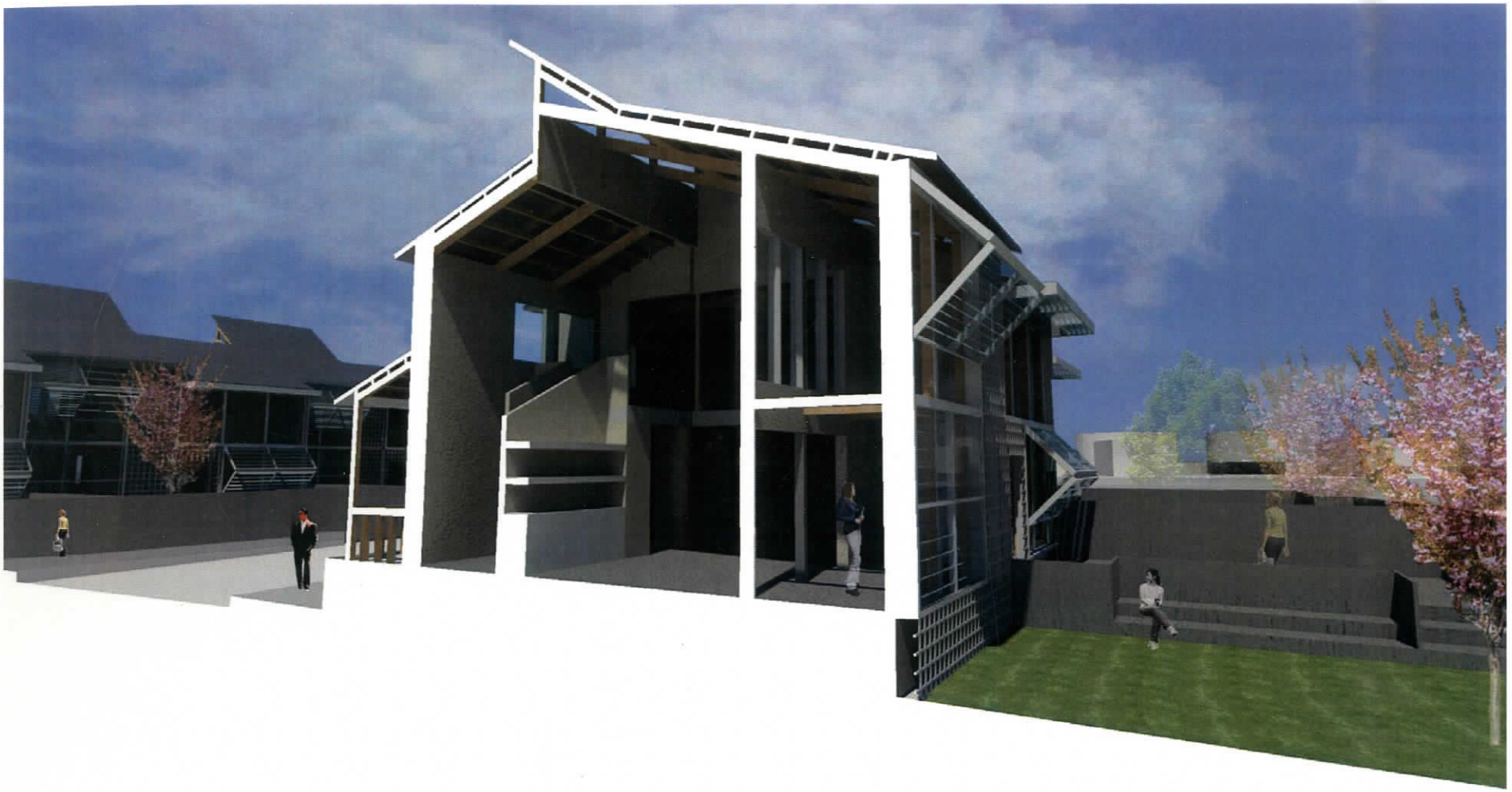

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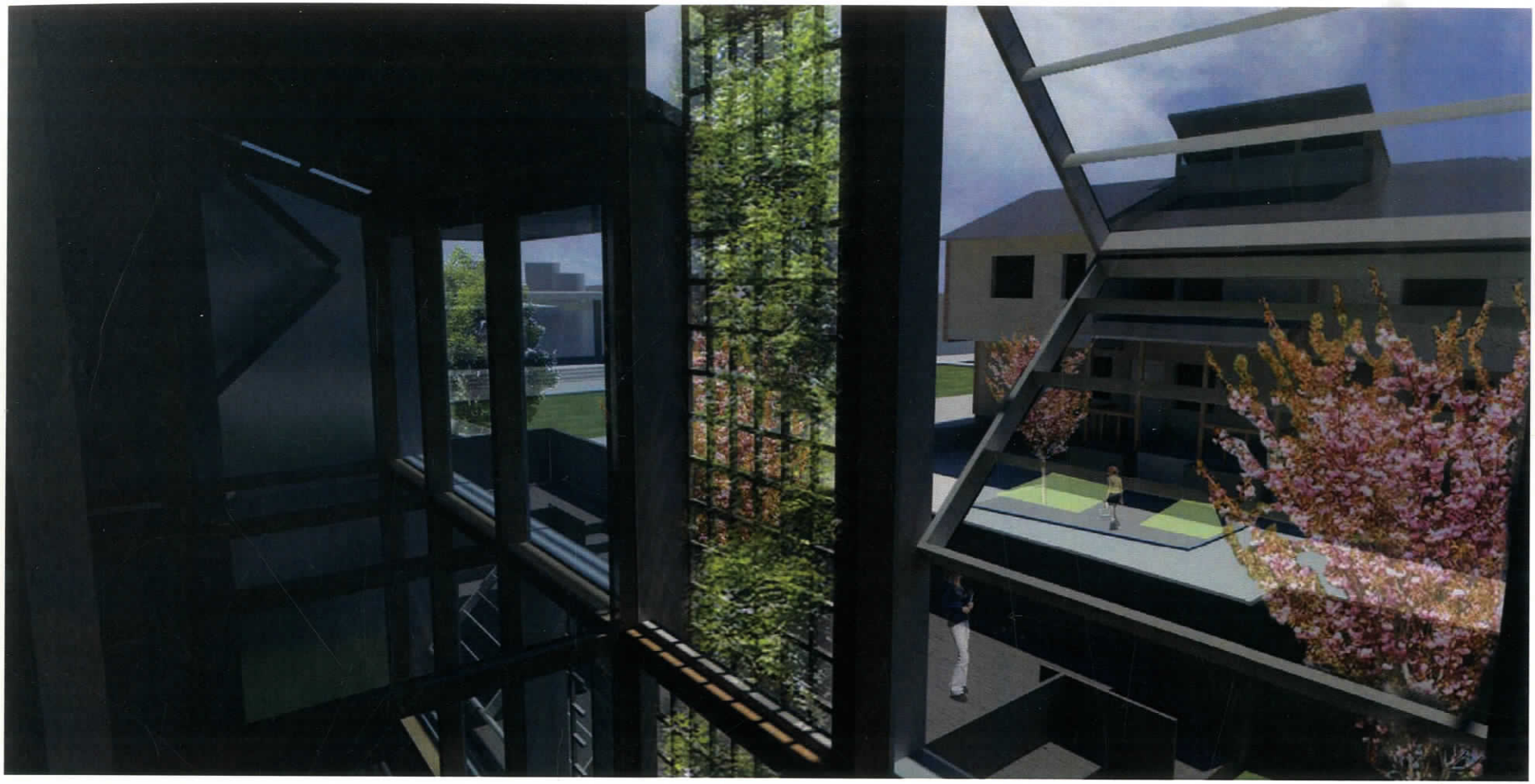

PART 5 THESIS DOCUMENTATION

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BIBLIOGRAPHY

Page 5, Diagrams 1
http://squ1.org/wiki/Daylight_in_ECOTECT

Page 5, Diagrams 2
http://squ1.org/wiki/Daylight_in_ECOTECT

Page 11, Diagram 3
http://www.oikos.com/library/solar_site_design/index.html

Page 11, Diagram 4
http://www.jedin.com.tw/new_page_46.htm

Page 13, Diagram 5
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Shows a systematic approach to the problem of environmental concerns. The approach of environmental engineering on the design of buildings and on the minds of the architects. The areas in which I will focus on within the book will be the descriptions of solar energy and how to utilize it in human environments.

"City of Stamford, Connecticut." Http://www.cityofstamford.org. 2007. QScend Technologies, Inc. 10 Oct. 2008.

This is the home website to the city of Stamford. The site provides background information about the city as well as its history and has detailed maps on land use and topography. This is a critical source for familiarizing with the city and seeing what the general problems and benefits are that come with it.

Cook, Jeffrey. "Award-Winning Passive Solar House Designs. Pownal," Vermont: Garden Way Publishing/Storey Communications, Inc., 1984: p. 107-112.

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Mastaedi, Arian. "Sustainable Architecture: High Tech Housing." Carles Bruto & Josep Minguet, 2003.

Provides examples of multi family, attached, rowe and detached housing. Includes detailed plans sections and axons in which to reference when form making. Should provide usful drawing for when it comes time for me to begin the design process.

McDonough, William. "The Hanover Principles: Design for Sustainability." http://www.mcdonough.com/principles.pdf. 1992. William McDonough Architects. 10 Oct. 2008.

The Hanover Principles are a set of statements about designing buildings and objects with forethought about their environmental impact, their effect on the sustainability of growth, and their overall impact on society. They were first formulated by William McDonough and Michael Braungart for planning Expo 2000 in Hanover and are presented in a copyrighted 1992 document.

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Provides examples of multi family, attached, rowe and detached housing. Includes detailed plans sections and axons in which to reference when form making. Should provide usful drawing for when it comes time for me to begin the design process.

Orr, David W. "Design on the Edge: The Making of a High-Performance Building." Cambridge, MA: The MIT P, 2006.

The first substantially green building to be built on a college Campus–encompasses more than the particulars of one building. In "Design on the Edge," David Orr writes about the planning and design of Oberlin's environmental studies building as part of a larger story about the art and science of ecological design and the ability of institutions of higher learning themselves to learn. The Lewis Center, which has attracted worldwide attention as a model of ecological design, operates according to environmental principles. It is powered entirely by solar energy, features landscaping with fruit trees and vegetable gardens, and houses a Living Machine, which processes all wastewater for reuse in the building or landscape.

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Salat, Serge, ed. The Sustainable Design Handbook CHINA. China: Tsinghus UP, 2006.

A direct and efficient understanding of how to design sustainable cities and buildings. It approaches the enviromental issues represented by sustainable urban development using a coherent approach integrating all

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scales and sectorial approaches. The book deals with the optimization of morphologies, passive solar systems and leading edge technologies in various climatic contexts. It also addresses the highest construction methods, systems, products and materials on the market. It also answers questions like how to control the complexity of a project and optimize its various parameters. This will be an essential tool to helping me evaluate my projects enviromental quality.

Schaeffer, John. "The Real Goods Solar Living Source Book: Your Complete Guide to Renewable Energy Technologies and Sustainable Living." Berkeley, Calif.: New Society Publishers, 2005: p. 239-241.

Segal, Jonathan. "Architecture + Development" Projects. <http://www.jonathansegalarchitect.com/index.html>.

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An excellent dictionary when it comes to the terms and uses of energy efficient design. Covers topics on energy design, energy fundamentals, design elements and then design analysis.

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Solar Architecture

Includes precedents and drawings of built solar architecture. Shows the many techniques to implementing and using solar panels to optimize the gains of the sun.

The Architectural firm of Harbor Point: Located in Stamford, CT (Currently working on projects along the Stamford marina)

Local firm currently working in Stamford, CT on a project about revitalizing the coastline. Their project currently is taking place close to where my project will hopefully be and could provide some fundamental information about the area.

Thomas, Randall, ed. "Environmental Design: An Introduction for Architects and Engineers." New York, NY: E&C FN Spon, 1999

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